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WESTINGHOUSE-LEBLANC REFRIGERATING PROCESS

THE USE OF WATER VAPOR AS A REFRIGERANT

IT IS WELL KNOWN that in connection with most refrigerating plants the rooms to be cooled contain a system of pipes traversed by a cold, nonfreezing salt solution which, after becoming heated some degrees in working, is restored to its initial low temperature in a refrigerator. Compression refrigerators consist of a vessel filled with the same nonfreezing brine into which a serpentine traversed by a liquefied gas is inserted. This liquefied gas, by its vaporisation and subsequent expansion, will yield the cold required to lower the temperature of the nonfreezing solution.

Water as a Refrigerant

NOW, it will be readily understood that water, because of its exceptionally high heat of vaporisation (i. e., the amount of heat absorbed on passing

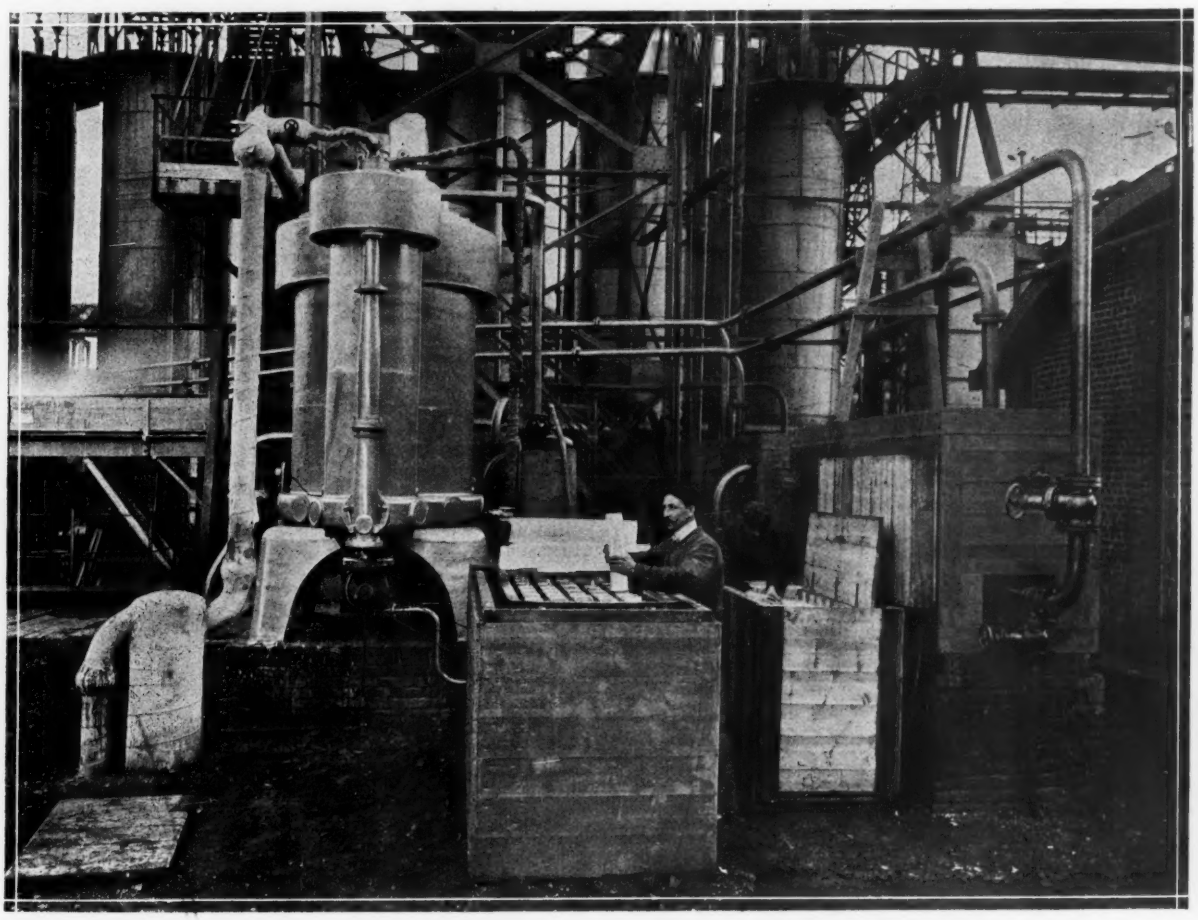


FIG. 4. LEBLANC REFRIGERATING PLANT AT THE BETHUNE MINE

from the liquid into the gaseous condition) would be infinitely superior to all the agents so far used for cold production. In fact, whereas the heat of vaporisation of methyl chloride, ammonia, carbonic acid and sulphurous acid are 360, 596, 106 and 167 B.t.u. respectively per pound at 32 deg. F., that of water is as high as 1092 B.t.u., however, on account of high boiling temperature of water which is +212 deg. (as compared with −13, −31, −108 and +14 deg. F. respectively in the case of the 4 refrigerating agents, most commonly used), the pressure of water vapor or steam is extremely low in the neighborhood of 32 deg., so that even a very small weight of this vapor will take up a considerable volume which, in order to

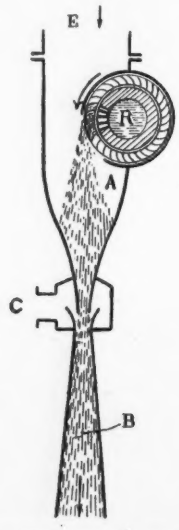


FIG. 1. PRINCIPLE OF WESTINGHOUSE-LEBLANC VACUUM PUMP

produce an appreciable decrease in temperature, would have to be drawn in at an enormous rate, such as no reciprocating or even centrifugal pump would accomplish.

These difficulties have been overcome in a most ingenious manner by Maurice Leblanc, a French engineer. As his refrigerating process is based on the use of the Westinghouse-Leblanc vacuum pump in connection with a condensing plant, a brief description of this interesting apparatus will first be given.

The Vacuum Pump

THE Westinghouse-Leblanc vacuum pump Fig. 1 consists mainly of 2 truncated cones A and B joined at their small bases, and a turbine pump rotating in the upper cone and which draws cold water at a high speed into the lower cone B, termed the discharging cone. The upper cone is connected with the exhaust E of a steam engine, the steam from which is drawn in and at the same time condensed, passing out, mixed with the water supplied by the turbine, through the discharging cone B.

This simple arrangement, which best illustrates the working principle, is only adopted in the case of small sized plants, whereas in any larger installations other arrangements, such as column condensers in the case of condensing a mixture of steam and water are found more economical.

In this case, the cold water that serves to effect condensation, enters at the top and falls in a spray into the condenser. The vacuum pump draws in, not the exhaust steam, but air saturated with moisture, which is discharged, along with the pump water, through the discharging cone. As this water is not heated to any appreciable degree, it may be used for condensing. The water already used for condensing and which has become mixed with that formed by the condensed steam, is drawn off by a centrifugal pump.

In the case of surface condensing plants, the arrangement used is practically identical, except that there is an additional pump, generally mounted on

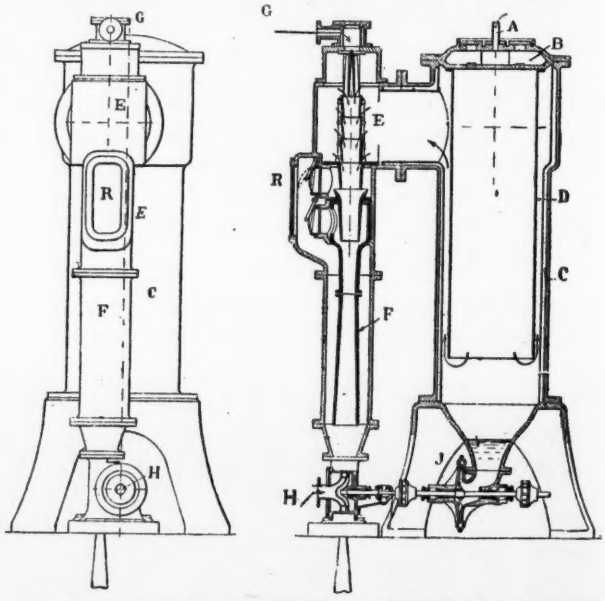


FIG. 2. ELEVATION AND VERTICAL SECTION OF A LEBLANC REFRIGERATING UNIT

the same shaft for drawing off the condensation from the steam, and sending it back to the hot well.

All these different arrangements are free from any reciprocating parts, the high-speed pumps, all of which are mounted on the same shaft, forming a very compact system.

The Leblanc Principle

NOW, the vacuum produced by the working of this pump is used in the Leblanc refrigerator, for cooling the refrigerating brine by the vaporisation of part of its water. This process is quite analogous to the working principle of the Carre ice machine, except that the vapors are drawn off by the pump, instead of being absorbed by sulphuric acid.

This is like an experiment which consists of filling a heat-insulating vessel with water, and placing the whole under the bell of an air pump: on rapidly producing a vacuum, part of the water is seen to disappear by vaporisation, whereas the remainder is frozen to ice.

Details of Operation

FIG. 2 represents the arrangement of the Leblanc refrigerating plant: After entering at A, the brine traverses a perforated plate B and falls in a fine spray into the vaporiser C, in which an extremely low vapor tension of 0.04 in. of mercury is maintained by the

ejector EF, in connection with the vacuum pump H attached to it. In order to prevent any small drops of liquid being carried along, the vapor is drawn in from the bottom of the cylinder D, while any water carried along falls back into the bottom as the vapor rises between the cylinder and the vaporiser sleeve.

Ejector EF is made up of 2 truncated cones joined at their small bases. The upper cone E, which receives the live steam from a boiler through G exerts a suction effect; it consists of different sections through the intervals of which the vapor from the vaporiser is allowed to enter. The lower cone F serves to diffuse the steam, which issues at a pressure of about 1.4 in. mercury to be condensed by the vacuum pump H. The working of the ejector can be watched through the manhole R.

The first tests made by Leblanc were intended to solve some purely theoretical problems and for this purpose the vapor ejector was arranged in the axis of a cylindrical barrel, the interior of which, lighted up by electric lamps, could be watched through thick glass windows. Inside this barrel was placed a vessel which, after a high vacuum had been obtained, was supplied with a spray of finely divided water that gradually underwent congelation, thus forming a thick cylinder of transparent ice. The possibility of producing ice on a commercial scale by means of this new process was thus demonstrated.

In order to continue these experiments with lower temperatures, the experimenter so arranged the interior of the barrel that the brine continually supplied from outside would fall through it in a series of successive cascades. This salt water was collected by a special pump, which discharged it into the open. This arrangement allowed the contents of a vessel of 79 gal. capacity to be cooled down to a temperature of —4 deg., thus showing the new process to be applicable to any problems of the refrigerating industry. The consumption of energy, even at those low temperatures, was found to be very satisfactory, 739.8 B. t. u. being extracted at a temperature of 14 deg. F. for 1 lb. steam used in the ejector.

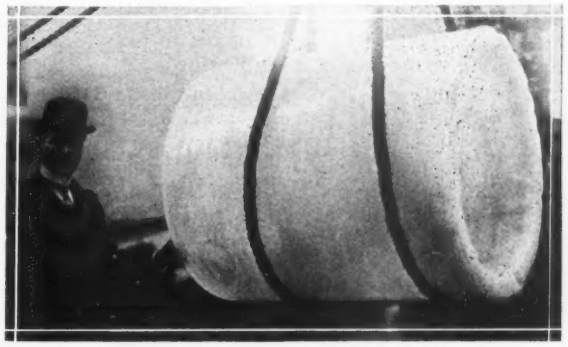


FIG. 3. ICE CYLINDER FORMED IN THE EXPERIMENTAL MACHINE

Brine Cooling System

THE most interesting plant so far designed on this system is that of the Bethune Mine, which moreover deserves a special mention because of the fact that artificial cold is there used for the first time in the treating of benzol.

The problem to be solved in this connection was maintaining at a relatively low temperature the tar oil

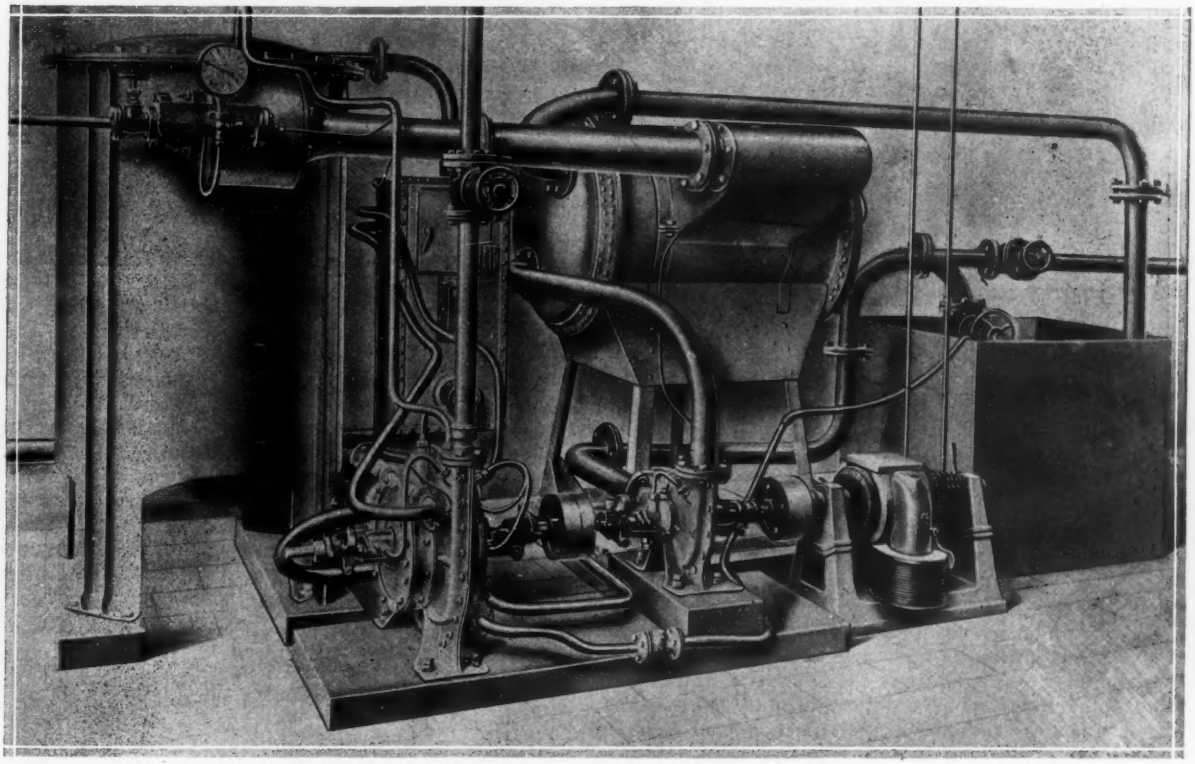


FIG. 5. PLANT USED ON BOARD THE DANTON

utilised for dissolving the benzol contained in the distillation gases of coal, as produced in the coke oven. These gases are conveyed in a hot condition to the lower part of contact towers, during the passage through which, in an upward direction, they come into contact with a spray of tar oil. This oil becomes heated during the operation and before being treated for the recovery of benzol, is made to pass through a serpentine immersed in a cold brine.

Now the refrigerating machine installed at the Bethune mines which is able to extract 142,884 B.t.u. per hour at 41 deg. F., is intended for cooling this brine. The plant comprises, however, in addition, a small ice generator producing 66.1 lb. of ice per hour in blocks of 17.6 lb. each, and which, in view of the difference in working temperatures, required a separate vaporiser. The ejector attached to the latter lowers the temperature of a nonfreezing brine down to 23 deg. and terminates directly in the condenser of the main refrigerator.

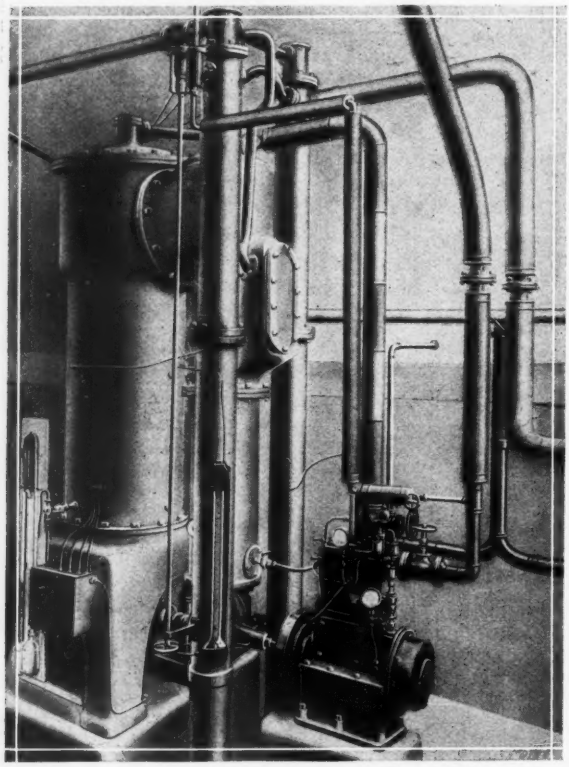


FIG. 6. PLANT FOR COOLING GELATINE AT NANTERRE, FRANCE

This condenser is of the injection counter-current type and is provided with a centrifugal discharging pump and a Westinghouse-Leblanc vacuum pump. The plant thus comprises the air pump of the condenser, a pump for discharging the condensed water, a brine pump for the larger refrigerator and a brine pump for the small refrigerator, all these pumps being driven by an electric motor.

This plant utilises the exhaust steam derived from a number of engines, which is supplied through a large conduit lagged with a heat-insulating material and provided with a blowoff cock.

Cooling Powder

ANOTHER interesting plant has been installed on board the Danton, one of the new French dreadnaughts, for the cooling of smokeless nitro-cellulose powder. It is well known that such powder is decomposed by an increase in temperature, and as this process disengages heat, it is bound to become accelerated at an even higher rate until it assumes the character of an explosion.

This makes necessary a refrigerating plant for keeping the water at a low temperature as required for safe storing of the powder.

In connection with the plant installed for this purpose on board the Danton, the hot air from the store rooms is conveyed into aero-refrigerators, there to be cooled, before returning to the powder stores. The aero-refrigerators consist either of a series of concave plates or of tubes with paddle wheels traversed by the cold brine and surrounded by the air to be cooled. Circulation of air is effected by a ventilating fan and that of the brine by the centrifugal pump of the refrigerating machine.

The latter is provided with a surface condenser and is of a remarkably light construction, consisting of steel sheets which on all parts coming into contact with sea water or brine are carefully galvanized. The machine occupies small space and has all the safety devices called for by official marine regulations. Instead of brine, it can, at low temperature, be operated with sea water, discharged after once passing through the aero-refrigerator. The steam drawn in from the vaporiser and condensed by the 2 ejectors is conveyed into the condenser with some admixture of working water (which is relatively cold).

The heat-insulated vaporiser consists of steel sheets and contains in its upper part, in the center of the brine sieve, a tube intended to prevent any accumulation of air above the brine. The suction end of each ejector is provided with a vertical sleeve of thin iron sheets which prevents any water being carried along in the form of small drops. The 2 ejectors are arranged symmetrical to one another; instead of being vertical, as in the previous arrangement, they are placed in a horizontal position, and can be shut off separately from the condenser by special valves.

The surface condenser is of cylindrical shape with an internally galvanized sheet steel sleeve. It is twice traversed by the water, the cold water first entering the lower tubes, and afterwards returning in an opposite direction through the remaining tubes. The admission of air is in the cold portion of the condenser and the steam is deflected by a screen towards the lower part of the condenser.

The 4 pumps are operated by 2 direct-current motors of the half-enclosed type, which are able to furnish 5.5 kw. at 120 volts and 1800 r.p.m.

Refrigeration in a Gelatine Works

A THIRD plant, installed for the Societe des Colles et Gelatines Francaises at Nanterre, serves for cooling the gelatine obtained after decanting the bouillon.

In order to ensure a rapid congelation of this gelatine, it is poured out in a thin layer on a long table, while the air at its surface is continually renewed by mechanical stirring devices. The ventilating fan which serves to effect this air circulation, drives the air alternately over the gelatine layer and the coils cooled by cold brine. The refrigerator is mainly of

the standard type represented in Figs. 2 and 3 and possesses a capacity of 39,690 B.t.u. per hour. The condenser, however, is of somewhat different design, being an ordinary mixing condenser with a centrifugal pump for the condensed water; the vacuum is kept up by a small steam ejector. In addition, the machine comprises a centrifugal pump for circulating and discharging the cold brine.

Refrigerating plants designed on the Westinghouse-Leblanc system are bound to prove especially advantageous in the case of refrigeration temperatures of 40-46 deg., as in connection with the installations above described. The remarkable economy of the system is further enhanced, whenever there is a sufficient supply of exhaust steam and water suitable for condensing, as in this case the exhaust steam can be used in place of live steam for feeding the ejector.

Another advantage lies in the fact that in connection with a Leblanc refrigerating plant, there is no gradual dilution of the brine; on the contrary, the loss of water undergone in the vaporiser always exceeds the amount of water absorbed by the air in the room to be refrigerated, so that an automatic water supply has to be provided for maintaining constant concentration.

The plants above described were installed by the Westinghouse-Leblanc Co., of Paris.

DRAINAGE OF PIPING

PROPER PITCH AND PROVISION OF DRIPS

AS showing the danger from water in a piping system and the importance of proper drainage some abstracts from an address delivered by Thomas Hawley before the American Institute of Steam Boiler Inspectors are interesting.

"A great many first-class practical engineers know there is such a thing as water hammer, but that it amounts to anything has never entered their heads. I had some experience with that in a plant I was connected with, where we ran a large main of 6-in. pipe down a wharf, and I think it was about 500 ft. long, and the water hammer in that pipe was of considerable trouble to them. In fooling with that question, is where I became interested in experimenting with the water-hammer problem; and we had some rather interesting experiences, and did some rather risky things. Perhaps if I had realized the high pressure developed with water hammer I might not have been so confident.

"We took some of the very best steel piping we could get, about 6 ft. long, and made it up in a similar manner, with a strong cap on each end, and along the line of the pipe I set a series of steam engine indicators, with specially constructed springs to record the high pressure, higher than you could record with the ordinary indicator spring, and then we put water in the bottom of that pipe and opened a steam valve right into that pipe; the first time we did it something happened right away. There was a noise that I think startled the neighborhood; I know it did everybody around the school.

"We had those indicators arranged with diagrams so as to show by vertical motion of the pencil just what the pressure in there was. I do not know what led me to string the indicators along the length of the pipe, because I supposed this pressure was all going to be noted at the end indicator; that the indicator in the cap at the end of the pipe was going to get a much higher pressure; I thought that it would be perhaps 300 to 500 lb., and the others would get nothing. The result showed that the indicators along the length of the pipe got quite as much pressure as those at the end. This pipe was something over 6 ft. long, and had 5 indicators in it. The highest pressure we had recorded was the one next to the end—not the end—and that recorded between 1350 and 1400 lb. pressure in the pipe at the time of the blow. It was all over in an instant; it simply made one record of pressure, that was the end of it.

"Well, I was not quite satisfied with that, because it had occurred to me that there might be a jump of the pencil, because the indicator pencil is a moving device which would give a vibratory motion. I have a number of indicators made a great many years ago, on a principle that gives little vibration. They were called reflecting indicators, made certainly over 20 yr. ago, and so made that the pressure would compress a very stiff spring in some cases, and in other cases would raise a diaphragm, which was connected to a mirror, and tilting this mirror would throw a beam of light on a screen. The very slightest motion of the mirror would be reflected on the screen. The motion of the mirror was very slight, so the momentum item would be very small indeed, and no vibration at all; and then we measured the pressure from the height of the beam as recorded according to the distance from the mirror.

"This indicator was used on this work. It made very little difference, because in some cases we got as high as 1300 to 1400 lb. pressure, and in other cases it fell below 1200 lb., but in no case did it go below 800 lb. as recorded by these indicators.

"After our first trial I was rather more guarded in making the experiments; but nothing at all happened. We made probably 15 or 20 experiments with that, and, as I say, the pressure varied 500 to 600 lb. in the smallest to 1200 to 1400 lb in the one next to the end of the pipe.

"What does that mean? Merely that when steam is turned on the water, something takes place. I used to think that in this long pipe the steam went in there and started the water in motion and got it going, and when it came to the end of the pipe the water did not want to turn the corner suddenly, even if the steam did; and the water kept on its way.

"Water pressure is very much the same as a bullet. If you get a bullet moving, it does not want to stop; and it occurs to me that in any pipe when you turn steam on and get the water moving, when it hits anything it hits, not as a matter of pressure, but with a bullet-like action. That is, it will take the plug out of the end of the pipe simply by its bullet action rather than by direct pressure.

"In the experiments we made we probably did not get a long pipe effect; we did not get the water moving. We got a condition in there that produced a tremendous pressure. I do not come out with any idea that we have threshed out this matter at all. It

occurred to me that there might be some expansion of the air and steam that was in there.

"I do not believe the water went far back in the pipe; it could not have gone very far. The water may have sprung back and compressed the steam momentarily, to create the pressure. I merely put the facts before you, so that you may think it out, with this one idea in mind—that when water hammer does occur in a pipe there is a tremendous pressure besides this bullet action, and why it is I am not prepared to say.

"Water hammer occurs in any place where water is allowed to accumulate or trap in. In this 6-in. pipe

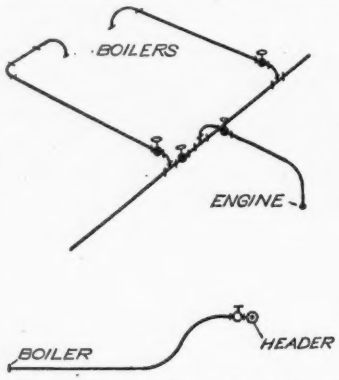


FIG. 1. PROPER CONNECTION OF BRANCHES INTO HEADERS

there was a sagging, and the water accumulated there every night; and when they turned the steam on in the morning they started this block of water going, and sometimes took the valve out at the end of the main. That was the trouble in that particular case, and all I did was to level up that pipe so there would be no water, and in doing that it may be of interest to know that they complained also of a constant leakage of the flanges. That I overcame by simply dripping the flanges at certain places.

"When you put steam into a long pipe the steam condenses and water accumulates, and it may be the temperature of the water at the bottom is lower than the temperature where the steam is. It is probable that that is the case, for these flanges always leaked at the top; and I could not conceive of anything else but that the water lying down in there would cause the pipe to expand less at the bottom in heating up than at the top. I remedied that by putting in drips at occasional intervals, and after that they had no trouble with the flanges. That being so, it is quite clear that the water was the trouble. They had 2 troubles—leakage and water hammer.

"There was a case where there was trouble over in a Cambridge steam plant in which an engine was wrecked. It has been suggested, and I thought so at the time, that there might have been some water hammer effect; but men could not see how the pressure of a water hammer could get on that portion of the engine which gave way. But those experiments of mine seemed to show that when there is water hammer the pressure is not alone at the end, but near the center and in the upper portions as well."

Caring for Condensation

WHILE condensation is the source of a considerable accumulation of water, the great difficulty in providing drainage is to take care of the sudden rushes which come from priming in the boiler or from the accidental opening of a valve which permits the sweeping up of accumulated condensation from the pipe in front of the valve. Provision must, however, be made at reasonable intervals for just these sudden rushes because they are sure to occur in every plant more or less frequently.

To prevent these rushes of water all pipe in which the flow is in the same direction at all times should be pitched with the flow of the steam at an inclination, as given in the January issue, of ¼ to ½ in. in each 10 ft. On main headers or in sections of pipe where the flow of steam may be in either direction it should, of course, be placed level, and an arrangement made at each end for taking out the water.

On large lines it is better to use gate valves than globe valves because there is no possible pocket for the accumulation of water, but if a globe valve is used it should be set horizontal whenever possible, as this allows the drainage to carry through better than the vertical setting. Care should be taken that wherever there is a dead end in which steam may condense when branches are shut off, a drip pipe is provided at the extreme end to carry away all water which accumulates and this drip connection should be kept clear of water at all times by a trap or otherwise so that water from the dead end will not back up into the rest of the header or main.

Where a pipe is reduced in the course of its run, an eccentric fitting should be used so that the bottom of the large size and small size lengths will be on the same level and the drainage carry straight on through. If it is impossible to do this, drainage should be provided at the end of the large section. The sizes of

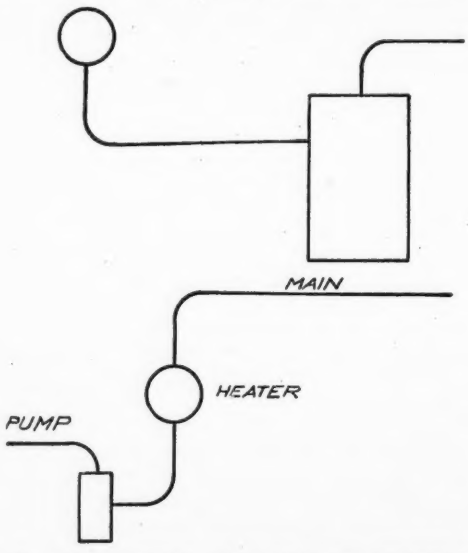


FIG. 2 . CONNECTIONS OF BRANCH TO HEADER FOR SUPERHEATED STEAM LINES

drain pipes found satisfactory on well covered mains are as follows: Up to 4-in. mains 1 in. drip lines. From 4½ to 8 in. mains, 1¼ in. drip; from 9 to 12 in. mains, 1½ in. drip; from 13 to 15 in. mains, 2 in. drip.

If at any point it becomes necessary to put an elbow, whether of short or long radius, or an angle valve into a main where there is any possibility of water carrying through, a drip pocket should be provided just preceding the elbow, so that any slug of

water which comes through may be caught and not strike the elbow, producing water hammer.

In the arrangement of drip piping care should be taken that no pockets are formed, as these will retard the free carrying away of water and result in the accumulation of water at the entrance to the drip pipe.

In providing drip pockets in main lines and at the bottom of vertical risers the pockets should be made the full diameter of the pipe and in length should be made from 10 pipe diameters for 4 in. pipe and under, down to 5 diameters for the larger sizes. These pockets may be made of a section of the pipe joined to the bottom of a tee or the same volume may be secured by the use of a larger section of pipe and a reducing fitting. In any case it is better to have a dished head on the bottom of the pocket for both strength and convenience in draining, the drip line to be carried from the lowest point in the head.

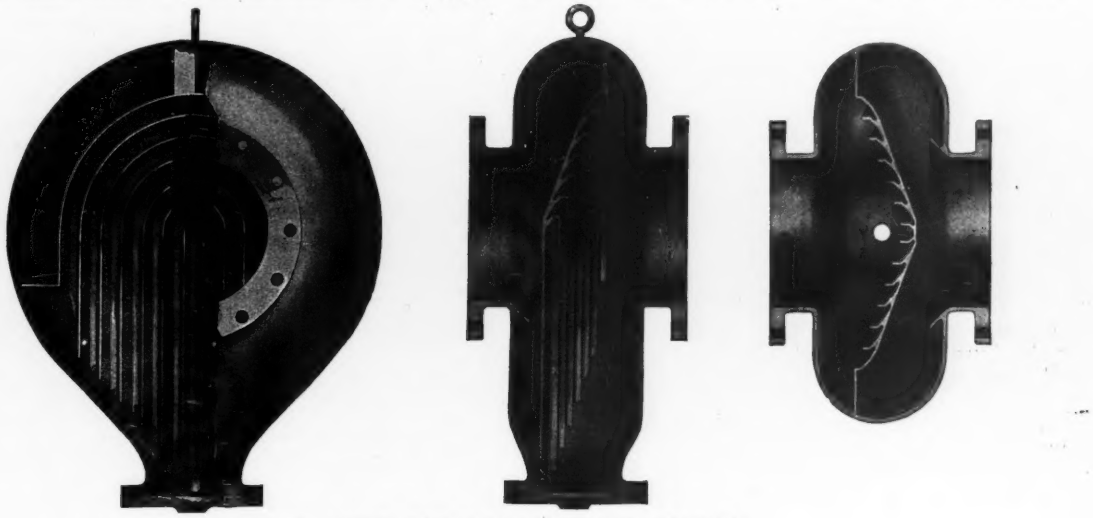


FIG. 4. VIEWS OF PACKARD EXHAUST SEPARATOR

Header Connections

FOR main headers connections should be taken from the top so that water will not carry over nor will steam be condensed in the pipe. In order to take care of the expansion it is best always to use a long bend elbow and, in order that condensation may drain out of the pipe when idle, a valve should be put in at the highest point. A good arrangement of connections and valves is as indicated in Fig. 1.

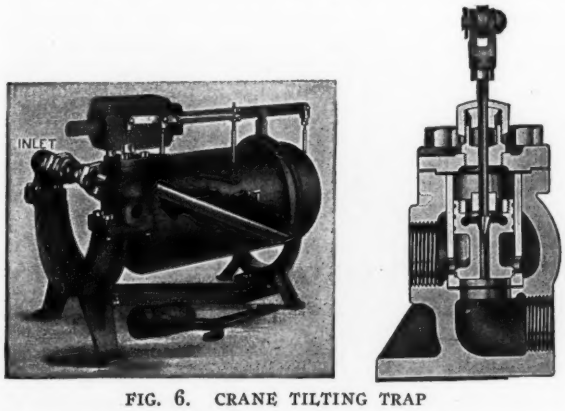


FIG. 6. CRANE TILTING TRAP

For lines carrying superheated steam it is better to take the outlet for the bottom of the header, carry it on to a large separator and take the steam supply from the top of this separator. If this is not possible, the alternative arrangement is to take from the bottom of the header a large drip line carried on to a separator and from this separator take the steam for the auxiliary units. The reason for this method of connection is that in a superheated steam line any accumulation of water on the bottom of the pipes must be avoided, otherwise there will be a considerable difference in temperature between the top and bottom of the pipe or header, resulting in a warping effect which produces rapid failure of the joints.

At the end of the main, where steam is delivered to engine or pump, a separator should be used to insure that water which may get past other safeguards shall be caught, and also to remove the moisture suspended in the steam.

The sectional views of the Packard separator of the Marion Incline Filter & Heater Co., Marion, O., explain fully its construction. The baffle is concave with ribs projecting uniformly, step by step, gradually approaching the inlet and the spaces between ribs are inwardly inclining angles, each terminating in a recessed groove behind the inner rib, this forming conduits to conduct all condensation below the path of the steam. Steam enters the separator, strikes the baffle and is thrown upward, passing around the top of the baffle and onward to the outlet. Around the outlet is a projecting ring to prevent any moisture from creeping along the sides of the separator and passing into the outlet pipe. With the reversal of current of the steam the tendency is to throw any moisture not caught by the baffles outward against the surface of the separator, and it would drain downward along this surface and be passed through an opening at the bottom into the water chamber.

For carrying off the water from drips and separators, the most convenient device is some form of trap.

As shown by the illustration, which is in partial section, the Çranetilt non-return traps consist of a tilting body balanced by a counterweight. When filled with water the body drops, raising the weight and opening a valve which allows the water to flow

out through the inclined pipe and the hollow axle. After discharge, the counter-weight overcomes the weight of the body and raises it, closing the outlet valve, and opening the inlet. Sectional view of the discharge valve is shown in the smaller illustration, this valve being raised as the trap body drops, thus giving large openings for the discharge. When the trap body rises the valve is closed on its seat.

ARE STEAM TRAPS ECONOMICAL?

By M. T. Simpson*

RUN your plant more economically." Doubtless almost every chief has had these orders handed him; and more than once, perhaps, but still the wherewithal to do it has not been forthcoming.

Now that manufacturing processes have been developed until almost absolute perfection is obtained and in some instances no hope of future improvement remains, more attention is being paid to the economical development of power. That means work and the expenditure of gray matter for the Chief. How is he to do it in the cheapest possible manner?

Of course the installation of fine economizers, "smoke burners," forced draft, and numerous other costly and expensive devices could be recommended, but the initial cost causes the "boss" to shy a little, with the result that the plant equipment remains the same, but the demand for economy still is made.

One of the chief troubles, and one of the coal pile eaters is water, not in the boiler, but in places where it is not desired, that is, in the steam system. Water in a steam system of any sort, whether in a drying kiln or a main steam line, reduces the efficiency of that system by a considerable amount. Its partial or complete elimination means development of more power by burning the same amount of coal, or the production of an equivalent power by burning less coal. The net economy resulting from water elimination is, of course, a variable quantity with a wide range, depending upon the nature of the system and quantity of water removed. It is almost needless to state that every water remover, separator or steam trap will show at least a fair profit on the investment; by fair we mean from 6 to 10 per cent showing that a steam trap is by no means a poor dividend payer. It is an unusually efficient and economical plant where the chief cannot spend about $100 for steam traps and not show a saving of at least $10 or ten per cent a year in his coal bills.

A single instance out of many may be cited. In a certain sugar refinery a series of 4 vacuum pans were drained into 1 trap. There was need for increased capacity, and talk of installing a fifth kettle to supply the demand. The engineer, taking the tip of an engineer salesman, suggested draining each kettle independently and putting a trap on each outlet, so that the steam coils could be freed from water as soon as it had condensed. His suggestion was carried out and an increased output of each sugar pan made the total capacity of 4 pans, with independent steam traps, equal to 4.5 pans with the single trap drain. Furthermore the cost of the 4 traps was about 1/25 that of a new pan. Was that a paying investment, and did that engineer make a hit?

In kiln work and under all conditions where steam is used for drying or cooking purposes, the secret of success is to condense the steam as quickly as possible and get rid of the water immediately. Water give up its heat to surrounding bodies very reluctantly and therefore is not as efficient as steam. For example, in house heating at least 60 per cent more radiating surface is required in water systems than is necessary when steam is used as a heat giving medium.

Steam at a temperature of 212 deg. F. in changing to water at the same temperature, gives up nearly 1000 heat units (the latent heat) per pound; then upon reaching the water stage the heat is given up very slowly, each pound only giving up one heat unit for each degree fall in temperature. From the foregoing it will be seen that the efficient system is one which is quickly freed from all condensation so that the water can be immediately discharged into the hot well and returned to the boiler, changed into steam and given another charge of a thousand heat units per pound. It is a parallel case to the merchant who gets rid of his stock quickly and continually "turns over" his capital as fast as he can; it doesn't take him long to get rich.

Now that it has been demonstrated that steam traps are a necessity, if a plant is to be run as economically as possible with the least expenditure for fuel saving equipment, let us consider what the requisites are for a perfect steam trap. In the first place, the design and construction of the trap must be as simple as possible. The average engineer cares very little for complicated devices that are liable to get out of order and cause him no end of trouble. He has enough work to look after his general duties without having to putter and fuss over steam traps. The design must be such that, when examination and repairs are necessary, the working parts may be instantly accessible and readily removed, without breaking a single pipe connection.

We now come to the internal features, chief of which is the valve or discharge orifice. This must be large and of ample size to free the trap of water quickly, when it is called upon to operate under maximum conditions. The method of opening and closing of the valve must be such as to eliminate as far as possible the scoring or cutting away of the valve seat. For this reason traps of the intermittent discharge type are considered better and longer lived than those of the continuous discharge type. In the latter the scoring of the valve seat is going on continually, while in the intermittent type the discharge takes place only at definite intervals. Running under their rated capacities intermittent discharge traps are operating or discharging from 6 to 12 seconds in every minute, which shows that the valve will last on an average about 9 times as long as a valve that is continuously discharging.

These principles have been shown by test and proven by experience as being the fundamental features of the perfect steam trap.

*Engineering Dept. the Nason Mfg. Co.

WASH BOILER DAY

CHIEF ENGINEER, having just come from No. 2 boiler plant to No. 1, where Riley formerly worked: "Say, Riley, do you know what feed they have on the boilers over at No. 2?"

Riley: "No! Chief, what have they on at No. 2?"

The Chief: "Well, they have the large feed pump, and 2 large injectors on over there. Isn't that an unusually heavy feed for the boilers they use?"

Riley: "Begorra, thin, they must be washin' out the boilers over there."

BOILER STRENGTH AND HORSEPOWER

BY THE SLIDE RULE AND BY FIGURING

IN nearly all examinations, a problem is found of figuring the working or bursting strength of a boiler shell. The solution is the same, whether the cylinder be used for a boiler shell, a condenser or a steam storage tank, but the strength is more frequently required for the boiler shell as this carries higher pressures.

Rule for Strength

FOR figuring the safe pressure on a cylinder the rule is: Multiply the tensile strength of material in pounds per square inch by twice the thickness in inches and divide by the diameter in inches; this gives the bursting strength considering the plate. But there are joints, and to get the strength of the actual cylinder this should be multiplied by the efficiency of the joint, whatever that may be, and this efficiency depends, of course, on the type of joint and the proportioning. The matter of proportions of the riveted joint and of the different types is too large a subject to be taken up here, but will be treated in a separate article later.

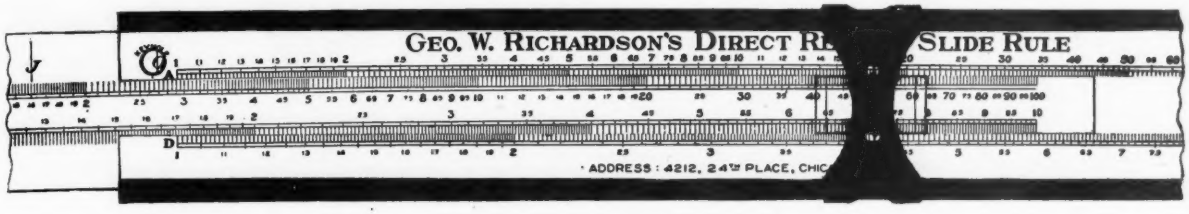


FIG. 1. LAST OPERATION OF COMPUTING THICKNESS OF BOILER PLATE, RUNNER AT 78 ON C SCALE AND READING OF 5855 ON D UNDER 10 ON C

If the working pressure is required rather than the bursting pressure, the value found for bursting pressure must be divided by a factor of safety which for ordinary boiler practice is from 5 to 8, the usual value being 6. The efficiency of the riveted joint will vary from 50 to 59 for single riveted, from 65 to 75 for double riveted and from 85 to 90 for triple riveted in lap joints; and from 80 to 85 for double riveted and 85 to 90 for triple riveted in butt joints.

Finding the Strength

THE easiest way to illustrate the use of this rule is by example, and if we assume that a boiler is 60 in. in diameter made of ⅜-in. iron plate, having tensile strength of 50,000 lb. per square inch, that we are to use a double riveted lap joint with the efficiency 80 per cent and a factor of safety of 6, we would then have $50{,}000\times2\times\frac{3}{8}\div60$; the result to be multiplied by 0.80 and divided by 6. Combining all these operations into one expression we get the fraction $\frac{50{,}000\times2\times3\times0.80}{8\times60\times6}$. When using the slide rule, as when using long hand computation, it is desirable to make quick cancellations wherever possible to reduce the number of operations. In the expression as given we have 2 and 3 in the numerator which will cancel into 6 in the denominator, and 8 in the denominator which will cancel into 0.80 in the numerator, giving 0.1, which will cancel out with one of the ciphers in 50,000, also the cipher of the 60 in the denominator will cancel out another cipher of the 50,000 in the numerator, leaving as the result 500÷6. This division can easily be done in the head but it is quicker on the slide rule. We set 6 on scale C over 5 on scale D, and under 10 on scale D we find 8335; the 35 is an estimate as between 8300 and 8350. Judgment tells us without hunting further that this is 83.35 lb. as the safe working pressure of this boiler.

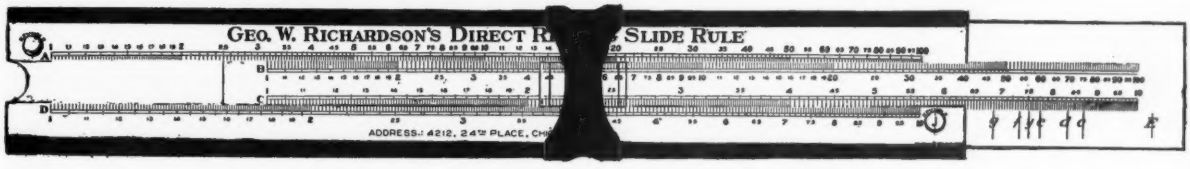


FIG. 2. SETTING AT "J" FOR FINDING CIRCUMFERFNCE OF A CIRCLE

A Second Problem

AS another problem, suppose that we have a boiler 72 in. in diameter made of a steel with tensile strength of 65,000 lb., plate 9/16-in. thick, efficiency of the joints 0.83 and the factor of safety 5. By the same rule as before we have as our expression when worked out: $\text{Pressure}=\frac{65{,}000\times2\times9\times0.83}{16\times72\times5}$

Cancellation will not reduce the number of slide rule operations materially in this problem. We would use, therefore, the regular method for a continued multiplication and division. We set 16 on scale C over 65 on D. Bring the runner to 2 on C and bring 72 on scale C to the runner, then bring the runner to 9 on C, and we find that this is off the scale D. This makes no difference, however, in the operation of the rule and we simply bring 5 on C to the runner. We now wish to carry the runner to 83 on C, but cannot do it as 83 is outside the range of operations, so the runner is carried to 1 on C and then 10 on C brought to the runner in order to reverse the slide. We can then carry the runner to 83 on C and under

this on D we find 1690 which, from the common sense of the case, is 169 lb.

Any number of problems can, of course, be solved by the same process, but the ones given are sufficient to illustrate the method. The reverse of this problem is to find the thickness of plate required when the working pressure is known.

Thickness of Plate Needed

BY transposition of the rule we have: To find the thickness of plate required, multiply the pressure in pounds per square inch by the diameter in inches, and divide by 2 times the tensile strength of the material; multiply this by the factor of safety and divide by the efficiency of the joint.

Assuming that we have a plate of tensile strength 65,000, that the efficiency of the joint is 0.78, factor of safety 6, and that we wish to carry 150 lb. pressure on a boiler 66 in. in diameter. We then have from the rule: $150\times6\times66\div(2\times65{,}000\times0.78)$, and expressing these operations in combined form we have:

$$\text{Thickness}=\frac{150\times6\times66}{2\times65{,}000\times0.78}.$$

To perform this operation we first take 2 on scale C and place it above 150 on D. Then bring the runner to 6 on C and bring 65 on C to the runner. Bring the runner to 66 on C and bring 78 to the runner. Under 10 on C we shall then read on D 5855, Fig. 1, which by the method of approximate cancellation is found to be 0.5855 in. or about 19/32 in., as the thickness of the plate. The thickness used in practice will be ⅝ in. The method of figuring for any other set of conditions would be the same.

Leaving out the factor of safety, which is a matter of judgment, and the efficiency of the joint, which depends on the kind of joint and the method of proportioning, the bursting pressure is seen to depend on the thickness, the tensile strength and the diameter. It is, therefore, possible to work out a diagram embodying these 4 values, so that from this diagram we can quickly find the thickness for any pressure, tensile strength and diameter within the limits of the diagram or find the bursting pressure for any tensile strength, diameter and thickness. We could then, in the case of safe pressure required, multiply the value for bursting pressure by the efficiency of the joint and divide by the factor of safety to get the working pressure; or for thickness required we could multiply the thickness for a given bursting pressure by the factor of safety and divide by the efficiency of the joint. Such a chart has been worked out and will be found in the Practical Reference Tables in this issue.

Boiler Capacity

WHILE ideas are changing rapidly with regard to the heating surface required to develop a boiler horsepower, and recent investigations with rapid flow of gases across heating surfaces seem to show that we shall shortly be halving or quartering our requirements for heating surface by the means of forced water circulation and forced gas circulation, still in present examinations the rating for the horsepower of a boiler is based usually on 10 ft. or 12 ft. of water heating surface per horsepower. The problem is frequently encountered of figuring the rated horsepower of a boiler.

Opinions differ as to the surfaces which should be reckoned on, but a safe method seems to be to consider half the shell for a return tubular boiler, the total tube surface and the area of the back head which is not taken up by the tube ends.

Figuring the Horsepower

FOR a boiler 54 in. by 16 ft., with 38 4-in. tubes, we would have then, first, to find half the area of the shell. Using the key settings on the Richardson rule we note first that 54 in. is equal to 4½ ft. Then

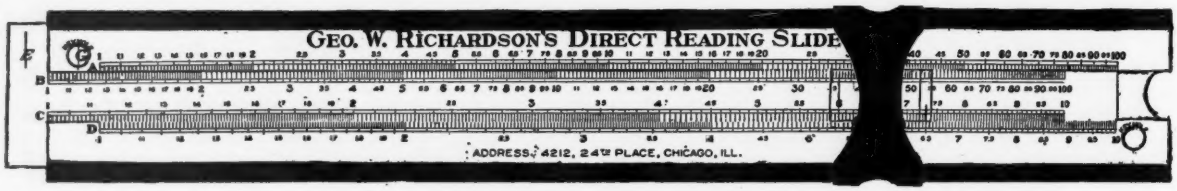


FIG. 3. SETTING AT G TO FIND AREA OF A CIRCLE

setting at j in the lower keyhole, as shown in Fig. 2, we find above the diameter 4½ on scale B, the circumference on scale A, which is 14.25 ft.

To get the surface of ½ the shell we must divide this circumference by 2 and multiply by the length, 16 ft. We therefore set 2 on scale B to the runner which is standing at 14.25 on scale A, and bring the runner to 16 on B and above this point on A we find 114 sq. ft. as the useful area of the shell. We might find the surface area of a tube in the same way but the dimensions of standard boiler tubes have been worked out for us by the makers, and the table as given by Morris, Tasker & Co., Ltd., will be found in the Practical Reference Sheet of this issue. From them we find that the length of a 4-in. tube for 1 sq. ft. of outside surface is 0.955 ft., hence a 16-ft. tube will have $16\div955$ sq. ft. and 38 such tubes will have this amount multiplied by 38. We have then $16\div0.955\times38$ and we set 955 on C over 16 on D and bring the runner to 10 in order to reverse the slide, then 1 on C is brought to the runner and the runner is carried to 38 on C and under this on D we find 633, the square feet in the tubes.

To find the area of the rear head we set G in the upper keyhole and over 4½ on C we find 15.75 on A which is the square feet in the head. From this must be subtracted the area of the tube ends. From the Practical Reference Table we see that the outside area of 1 4-in. tube in square feet is 0.0872 and this must be multiplied by 38. We therefore bring 1 on C to 872 on D, and below 38 on C we find 3.31 sq. ft. as the area of the tube ends. Subtracting this from 15.75 we get 12.44. Adding together now the 3 values for shell, tubes and head, we have $114+633+12.44=759.44$ sq. ft. of heating surface. If we assume the older value of 12 sq. ft. of heating surface per horsepower, we then divide 759.4 by 12, that is, we bring 12 on C over 759.4 on D, and under 1 on C we find 63.2, the required rated horsepower of the boiler.

SMOKELESS FIRING TESTS IN GOVERNMENT AND PRIVATE PLANTS

By Carl S. Dow

IT has been well understood for some time by combustion engineers that the most effective way to solve the problem of smoke production with soft coal is by means of underfeeding and providing sufficient combustion space in the furnace. The recent movement for the prevention of smoke in cities has led many people to an investigation of how best to accomplish this result who would otherwise not have understood the proposed methods upon which effective smokelessness is based.

The fallacy of attempting to provide smoke catchers or other devices intending to change smoke after it has formed into something else or to deposit it in various ways so that the escaping gas should be clean has been demonstrated many times. Smoke once formed cannot be suppressed and therefore those interested are rapidly arriving at the unanimous opinion that the place to attack the smoke problem is in the furnace. This narrows the field of investigation down to a straight combustion problem and the combustion engineers have proved conclusively that underfeeding of the coal, combined with proper air regulation and sufficient volume for the burning of volatile hydrocarbons are the necessary requirements for success.

In a Washington Department Building

THE experience of the superintendent of the State, War and Navy Building in Washington, D. C., is an added instance of successful smoke prevention by this means. The problem was unusually aggravated in this case because of the size of the boiler plant in this building, which is probably the largest of the government buildings in Washington, and the fact that the smoke laws of the city are exceedingly rigid. The power plant consists of 4 185-hp. Babcock & Wilcox boilers, 2 turbo-generator sets, hydraulic elevator service, and a combination steam and hot water heating system. The boilers were originally hand fired and it has always been considered necessary to burn hard coal under them in order to conform to the smoke ordinance. In order to work economy in operation it was decided to attempt the burning of soft coal by installing a trial underfeed stoker.

Hand vs. Stoker

AFTER this stoker had been installed a series of comparative tests on the stoker fired boiler and on the hand fired were run in order to get accurate figures on which to base a request for an appropriation from Congress to equip the remaining boilers with stokers. The results were conclusive. Not only did the Taylor Gravity Underfeed type stoker burn the soft coal smokelessly at all loads but it evaporated the same amount of water as the hand fired boilers on 60 per cent as much coal, while the efficiency was nearly 15 per cent higher. The stoker furthermore demonstrated its ability to carry very heavy overloads continuously, and it was decided to attempt to carry the entire load of the building on the one stoker-fired boiler. Accordingly the fires were pulled under the hand-fired boilers and the stoker fired boiler has been carrying the load continuously ever since.

A careful comparison of coal burned showed that another stoker could be bought and would pay for itself without the necessity of obtaining any further appropriation. The coal being used on this stoker installation is New River run of mine, analyzing about 14,700 B.t.u. per pound, and with this coal a combined efficiency of approximately 80 per cent is obtained.

In ths case, the underfeed stoker which was installed primarily to solve the smoke problem has gone much further and changed the entire operating method of the station. This of course is possible because of the remarkable overload capacity of stokers of this type. The correlation of air and coal supply makes the stoker's capacity limited only by the capacity of the fan engine which not only furnishes the forced draft but also operates the stoker mechanism. By means of the mechanical underfeeding, the coal is forced to pass up underneath the fire bed, becoming gradually heated as it advances and distilling off the volatile matter before the fixed carbon reaches the temperature of combustion. The distilled gases then pass up through the incandescent fuel bed and are burned completely, thus obviating any chance of smoke being formed.

A Private Plant

THE high overall efficiency obtainable in power house practice by the use of water-tube boilers and properly designed stokers is well illustrated by a test recently conducted at the Public Lighting Power Plant, Detroit, Mich. The unit under test was a 400-hp. Stirling boiler, class "0" fired by a Taylor gravity underfeed stoker manufactured by the American Ship Windlass Co. of Providence, R. I.

No attempt was made to overload the boiler, the intention being to ascertain what efficiency might be expected at normal rating under the usual operating conditions. Accordingly the load on the boiler was kept at or near 400 hp., and the extremely good regulation possible wtih this type of equipment was demonstrated by the fact that the average horsepower developed was only 4 per cent higher than the builders' rating. This result is due to the carefully designed control of both air and coal supply peculiar to this type of stoker. The detailed figures obtained are as follows:

Test Results

THE boiler was a Stirling of 400 hp. rating, class 0, with 4013 sq. ft. of heating surface and a grate 6 ft. long by 7 ft. 3 in. wide, giving 43.5 sq. ft. of grate surface. Forced draft was used under a Taylor Gravity Under-Feed Stoker, the test lasting for 8 hrs. The barometer showed 14.4 lb. atmospheric pressure and the steam pressure registered on the average 162.4 lb. gage. Draft measurements were 1.24 in. water pressure in the box under the stoker, 0.22 in. in the furnace, 0.62 in. in the breeching, and 1 in. in the stack.

Temperatures were as follows: Outside air 35 deg. F., boiler room 64 deg. F., feed water 158 deg., steam 371.3 deg., escaping gases 516 deg. Meadow Creek coal was used from West Virginia, showing a heating value by calorimeter test for the dry coal of 14,584

B.t.u. per pound, and the heating value of combustible 15,482 B.t.u. The moisture tested 0.85 per cent, and the ash 7 per cent.

Total fuel used was 9806 lb., giving 9723 lb. of dry coal and 9038 lb. of combustible. This gave for the 8-hr. test as the fuel per hour, 1215 lb., the combustible per hour 1130 lb., the fuel per square foot of grate surface per hour 28 lb., and the combustible per square foot of grate surface per hour 26 lb.

Water used was 104,525 lb. and steam was 99.4 per cent dry giving 103,898 lb. of water evaporated into steam.

At the given pressure and feed-water temperature the factor of evaporation is 1.1071, so that the equivalent evaporation from and at 212 deg. was 115,025 lb.

Water per hour figures out at 13,065 lb. giving an evaporation into dry steam of 12,987 lb. per hour or an equivalent evaporation of 14,378 lb. an hour. Carrying these figures to their conclusion, we get as water evaporated per pound of dry coal 10.68 lb. and the equivalent from and at 212 deg., 11.82 lb. Evaporation per pound of combustible is 11.49 and the equivalent from and at 212, 12.72 lb. Evaporation per square foot of grate surface per hour is 298 lb. and the equivalent from it at 212 deg., 330 lb. The evaporation per square foot of heating surface per hour is 3.21 lb. and the equivalent from and at 212 deg. is 3.58 lb.

Reducing the performance to horsepower we find it to be 416.7 as the actual performance which is 104.17 per cent of the builders rating. The efficiency of the boiler figures at 79.3 per cent and the combined efficiency for boiler and furnace are 78.5 per cent.

Proximate analysis of the coal gave as moisture 0.85 per cent, volatile matter 36.35 per cent, fixed carbon 57 per cent, and ash 5.8 per cent. This ash determination does not agree exactly with the determination from the total pounds of ash which was 685, and the total fuel used which was 9806 lb. Flue gas analysis showed the oxygen to be 8.2 per cent, the carbon monoxide 0.26 per cent and the carbon dioxide 11.6 per cent.

COAL HANDLING PLANT OF THE LA SALLE HOTEL

COMBINATION SYSTEM USING SCREW AND BUCKET CONVEYORS

By H. H. Kress

COAL handling and storage equipment for the LaSalle Hotel power plant consists of 6 concrete bunkers 14 to 15 ft. wide and 18 ft. high on the level of the boiler house floor, located entirely under ground at the north side of the hotel along the alley way. All coal coming to the plant as well as the ash going out are handled mechanically and entirely under ground by a plant installed by the Jeffrey Mfg. Co., of Columbus, Ohio, built especially for the particular requirements of this location.

FIG. 1. DUMPING COMPARTMENT IN THE TUNNEL

As in many of the large buildings in Chicago, the coal is delivered by means of the cars of the Illinois Tunnel Co., which are located approximately 14 ft. below the boiler house floor level. This coal is dumped into a hopper alongside the tracks of the Tunnel Co., and passes to a screw feeder which in turn carries it forward some 15.5 ft. and deposits it in regular quantities on the elevator. The dumping compartment is shown by the photograph, Fig. 1, and is indicated also at A, in the sectional view, Fig. 2.

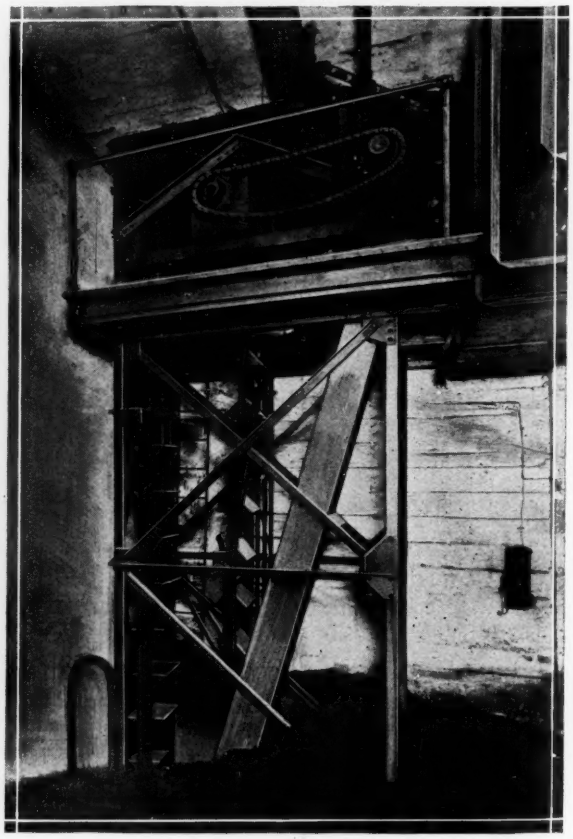


FIG. 3. ELEVATOR HEAD AND DRIVING MACHINERY

Lifting about 45 ft. through a vertical shaft is done by means of a bucket conveyor, and these buckets in turn deliver it to a 12-in. spiral conveyor, approximately 100 ft. long, which is carried in a trough resting on saddles which in turn rest on the partition walls between individual bunkers. In the bottom of the trough of this conveyor are gates controlling the flow of coal to the bunkers, these gates being operated by means of levers and reach rods so that the flow of coal can be absolutely controlled from the boiler house floor without going into the bunkers.

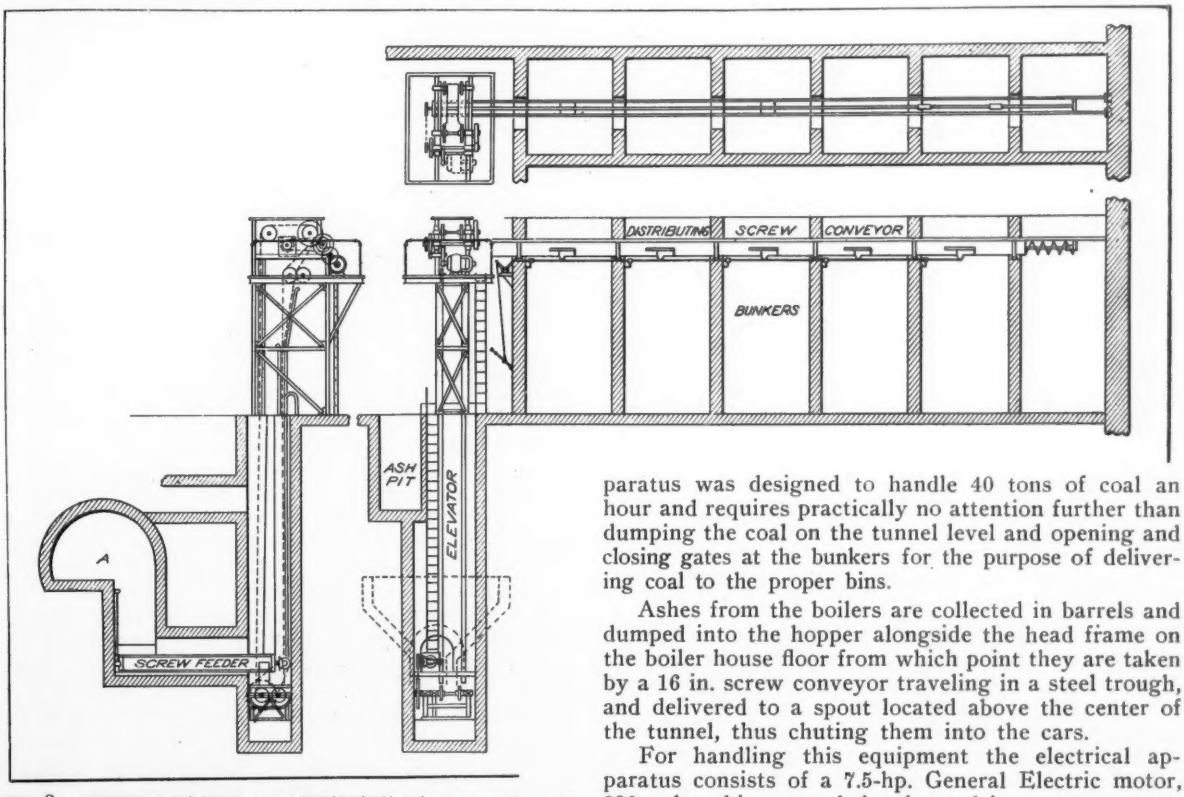


FIG. 2. SECTION OF THE ARRANGEMENT OF COAL AND ASH HANDLING SYSTEM OF THE LASALLE HOTEL

For the lifting elevator a double strand of combination steel and malleable chain with centrally hung V buckets is used, the entire chain and bucket structure being fully encased as shown in the photograph, Fig. 3. That part of the elevator structure which is above the boiler house floor, is supported by a substantial iron frame which carries all motors and driving machinery required, for the elevator, distributing conveyor, and feeding conveyor at the bottom of the pit.

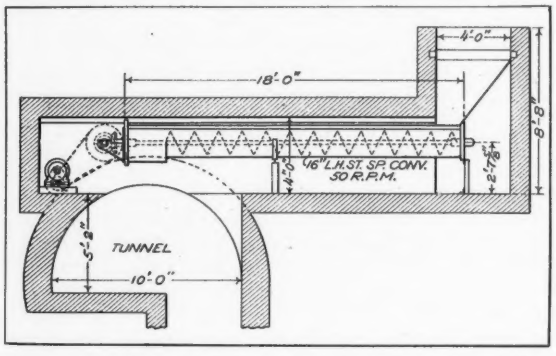


FIG. 4. SECTION OF ARRANGEMENT OF ASH CONVEYOR

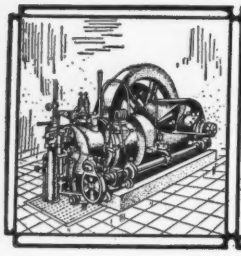
Location of the head frame and the connection between it and the different parts of the conveying system are shown on the drawing Fig. 2. The apparatus was designed to handle 40 tons of coal an hour and requires practically no attention further than dumping the coal on the tunnel level and opening and closing gates at the bunkers for the purpose of delivering coal to the proper bins.

Ashes from the boilers are collected in barrels and dumped into the hopper alongside the head frame on the boiler house floor from which point they are taken by a 16 in. screw conveyor traveling in a steel trough, and delivered to a spout located above the center of the tunnel, thus chuting them into the cars.

For handling this equipment the electrical apparatus consists of a 7.5-hp. General Electric motor, 220 volts, this motor being located in a compartment above the shaft and connected to the ash conveyor by sprocket chains and sprockets. Also a 3-hp. Crocker-Wheeler back geared motor located in a chamber above the tunnel and driving the screw ash conveyor by a chain and sprocket, the total speed reduction from motor to conveyor being 20 to 1.

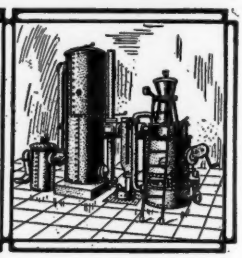
MAKING PERFECT BLUE PRINTS

MANY novel and patented devices have from time to time been designed for the purpose of ensuring clear blue prints when printing in large frames. One of the simplest of these has been in use in a Belgian factory for many years, and has proved satisfactory in every way. In this factory the prints, which are in many cases of huge steam engines, have to be made an exceptionally large size, and the difficulty of ensuring perfect pressure of the paper in the frames is overcome by using thin rubber cushions the size of the frames, which are placed between the paper and the wooden back. Air is then blown into these cushions by means of the mouth which gives just sufficient pressure to ensure perfect contact, without bulging the wooden back or the large glass front of the frame. By using this simple device the largest prints can be produced with perfectly sharp lines all through, and spoiled and blurred prints are entirely avoided.—The Dodge Idea.



Gas Power Apparatus

Producers, Engines and Industrial Applications



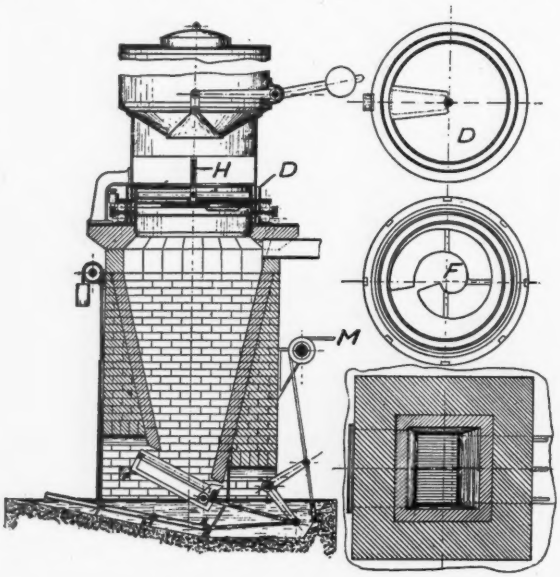
A NEW GAS PRODUCER

FOR USING A MIXTURE OF COAL AND LIGNITE

By W. A. Tookey

IT IS FULLY RECOGNIZED that it is a simple matter to obtain gas from a gas producer of whatever shape or dimensions may appear to be suitable from the point of view of the designer, but it is a matter of much more difficulty to obtain a uniform quality of the gas under all conditions of working.

There is a considerable difference to be noticed in the working of a producer which is called upon to supply gas in accord with the varying needs of an engine generating power in ordinary factory operation and that of a similar apparatus always supplying a constant quantity of gas for the purpose of some or other industrial process that is more or less continuous and practically uniform in respect to the quantity of heat required.



SECTION OF THE KUPFERBERG GAS PRODUCER

It is especially for use in glass works and for metallurgical processes that the new producer has been evolved. According to the fuel to be used it is necessary to provide suitable details that will make for the close regulation of the fresh fuel, admitted to the furnace within the generator, and also for the removal of ashes from the lower portion of the fire.

Gratebars and Lining

USE of gratebars for the support of the fuel, for example, is necessary only when the material burns to powdery ashes. When the incombustible residue is of a porous nature it is quite possible and indeed advantageous to dispense with firebars and to permit the fuel to rest upon a pyramid of ashes. The capillary action that is then set up draws the water through the ashes to the lower portion of the fire and by the generation of steam softens the clinker that, with some fuels, has a tendency to mass together and impede the upward passage of the blast and the downward settlement of the fuel.

Again, for fuels that contain a large portion of ash, it is desirable to provide the internal lining with parallel sides or even to allow a greater width at the base than at the top. With fuels in which but a relatively small amount of incombustible matter is present, it is advantageous to make the firebrick lining smaller at the base than at the top.

In a producer designed in accordance with the latter condition it is possible to permit the lining to be rectangular in section instead of circular as is the more common, because with a tapering wall—increasing the sectional area from the grate upwards—any free air that would have a tendency to creep up the corners would be trapped and be made to pass through the incandescent upper layers and thereby be converted into good gas.

An advantage of a rectangular section of a gas producer is that repairs can always be made with ordinary firebrick obtainable from almost any retailer, whereas with circular bricks a special order is usually necessary because of the varying internal and external dimensions of the generators as made by different firms.

These remarks explain the reason for the internal arrangement of the producer illustrated in the accompanying figure. Attention may therefore be directed to other features that call for special notice and especially those connected with the charging of fresh fuel, the distribution of the latter evenly over the whole surface of the fuel bed, and the removal of the ashes from the water bottom of the producer as well as the clearing of the ashes from the opening between the firebars.

The Feeding Hopper

THIS consists of 3 parts. Into the upper compartment the fresh fuel is delivered through an opening which normally is covered by a lid resting in a

water groove. At the bottom of this compartment the ordinary form of cone plug is fitted being operated by a lever with a ball counterweight of the usual type. This compartment can be of any desired size and may be large enough to have a storage capacity sufficient for 24 hr.

Below the cone plug is a second compartment divided into 4 quadrants into which the coal descends. As will be seen from what follows, the base of this compartment rotates and the partitions alluded to are to prevent the fuel that is below the cone plug moving with the base. The partitions mentioned are shown in the drawing at H.

The base of this second chamber is formed of a circular plate, around the periphery of which is cast a water groove within which the fuel chamber dips, being supported by brackets from the top plate of the main casing in the manner shown. This top plate or disk has a hole, covered at a definite distance above by another plate, as shown in the plan view at D. Through the hole the coal falls onto another plate to be presently referred to. The provision of the cover over the hole is to avoid the superimposed fuel packing so closely that it would wedge in passing through the opening.

It will be realised that the coal admitted to the second compartment through the cone plug rests upon the plate and as the latter rotates while the divisions in the upper compartment remain stationary, the fuel is scraped, so to speak, under the small cover and falls through the hole in the rotating plate.

Immediately below the upper plate is a second rotating plate and for the purpose of explanation it can be said that the space between the 2 forms the third compartment of the feeding device. As a matter of fact the 2 plates are fitted closely one above the other with no space between which might encourage the coal to collect. The plan of the lower rotating plate is shown at F and it will be seen that in this, a spiral slot is arranged extending from the outer edge to the centre of the producer. This plate is also fitted with a water groove into which a projecting rim from the upper plate dips to form a gas tight joint.

Around the edge of the lower plate a rack is provided with which a ratchet engages and so imparts the necessary rotary motion, with an arrangement whereby the speed of rotation can be adjusted, as may be found necessary to suit the conditions of operation. Both plates rotate together for one revolution, and supposing the opening of the top plate to be in register with that portion of the lower plate that is nearest to the wall of the producer, the coal will then be distributed over that portion of the fuel bed below in the producer proper.

After the completion of one revolution the lower plate leaves the upper one for ⅛ revolution, then again joining it for one revolution. This recurs continuously and distributes the fuel in concentric circles ensuring a uniform height of the charge and also replacing the fuel as it is consumed.

The Removal of Ash

FROM the illustration it will be seen that the firebars are placed at an angle above the water bottom and enclosed within a chamber formed of the brickwork on 2 sides and of 2 plates which dip into the water at either end of the firebars; that above the slope provided for the removal of ashes from the water bottom, being provided with a counterweight for convenience of access to the gratebars when occasion demands.

By means of a system of levers operated by wire rope passing over guide pulleys shown at M, a number of teeth interspaced with the firebars are moved throughout the length of the latter from time to time so as to ensure the maintenance of sufficient area for the passage of the blast through the fire. These teeth are connected to the system of levers by a framework. This is also connected to another frame supporting 3 flaps or wings which scrape the slope of the ashpit in the manner indicated in the illustration.

The wings rise on the downward stroke and turn down on the upward stroke and thus push the ashes out of the water so that the stoker can remove them without disturbing the working conditions of the producer in any way. The patentee of the producer, Mr. Kupferberg, claims that the producers of this design now at work are giving every satisfaction and from the records obtained from CO_2 recorders the amount of this gas never rises above 2 per cent while he has charts showing as low an average as 0.7 per cent.

Producer Capacity

AS a matter of interest as to the capacity of these producers it may be mentioned that the patentee gives the following figures from his experience as to the necessary depth of the fuel bed with different fuels under forced draft: Coal, 33 in.; lignite, dry, 34 in.; lignite, damp, 30 in.; peat, solid, 36 in.; peat, spongy, 55 in.; wood, dry, 52 in.

The following figures are also given as permitting a comparison to be made between the ordinary type of gas producer used for heating purposes and the producer described in the foregoing. The figures refer to the rate of fuel consumption in pounds per square foot of mean sectional area of the firebrick lining.

Fuel	Ordinary producer	Automatic producer
Coal	24.8 lb.	33. lb.
Lignite	34.2 lb.	39.3 lb.

It will be noticed that the above figures show that a much higher rate of fuel consumption per unit of area is obtained than is the usual practice in America, namely an average of 10 pounds of coal per square foot. It closely agrees with the average performance of gas producers used for power and heating purposes, under suction or pressure, with anthracite in England, however.

In conversation with the patentee the writer raised the doubt as to the small proportion of carbon dioxide contained in the gases as claimed in the foregoing paragraph and elicited the fact that during the operation of the producer the stokers frequently consolidated the fuel bed by poking down through apertures provided in the top plate of the producer so as to preserve an absolutely compact fuel bed without blowholes. It appeared also that the analysis was obtained when using a mixture of equal weights of ordinary bituminous coking coal and brown coal.

Experience with other producers would tend to show that the percentage of carbon dioxide in producer gas as usually generated would average 5 instead of 2. In the working of the producer described no moisture was admitted to the blast other than that obtained by the evaporation from the water in the ashpit.

IGNITION AND ENGINE EFFICIENCY*

By Roger B. Whitman

SECURING efficiency in an internal combustion engine is dependent upon a knowledge of many problems, and it is on the solving of these problems that success depends.

Efficiency is, of course, understood to be the relation of the power output of an engine to the theoretical power that may be calculated from the heat value of the fuel, or, in other words, the relation of power output to fuel consumption.

The impossibility of securing, or even of approximating this theoretical power is due to certain losses that cannot be entirely prevented, and the greatest efficiency will be secured by reducing these losses to a minimum.

Our subject requires a discussion of the losses that may be due to the improper handling of the mixture in the combustion space, and as a preliminary we must examine into the conditions existing in the cylinder of the engine during a certain portion of the cycle.

Ideal Condition

THE ideal condition would be realized, if it were possible, when the piston is at the end or top of the compression stroke. When the piston is at this point, the combustion space is smallest, and the combustion of the charge confined within it will result in the attainment of a higher pressure than could otherwise be produced.

The mixture, previous to combustion, will have been compressed to the extreme permitted by the design, and in consequence it will have been raised to a high temperature, which would be further increased by the absorption of heat from the cylinder wall and piston head.

As ignition is understood to be the elevation of the temperature of a certain portion of the mixture to the point at which it will burn, it is clear that the greater the preliminary heating, the less will be the tax imposed on the ignition system. Furthermore, the position of the connecting rod will be most favorable when the piston is at the end of the stroke, and there will be no back pressure exerted through it against the crank shaft, which would result in the retarding of the rotation. Hence, there will be no objectionable side-thrust of the piston against the cylinder wall, and lubrication in consequence will be simplified.

That this condition cannot be realized is due to the period of time required for the combustion of the mixture, which makes it necessary to cause ignition at such a point in the stroke that combustion will be complete when the piston reaches its upper dead center.

The power produced will be in direct proportion to the quantity of heat that is expended in expanding the gases, and as the charge of mixture has a certain and definite heat value, the consequence is that the most satisfactory results will be produced when the greatest proportion of the heat is expended in this way.

Radiation Losses

IF the walls of the combustion space could be made of a material that had not the property of conducting heat, a very great proportion of the heat value would be expended in the manner desired.

This is not the condition, however, and in consequence we must regard the combustion space surfaces as offering an opportunity for the escape of heat, and in securing efficiency it follows that the heat loss from this cause should be reduced to the lowest possible point.

The longer the burning mixture is in contact with the walls of the combustion space the greater will be the opportunity for the absorption of heat by the metal, and this points directly to the condition stated above of having ignition occur when the piston is at top center, and in consequence when a minimum surface is exposed to the heat.

Best Ignition Point

NOT being able to attain this end, the next best solution is to have ignition occur as late as possible in the compression stroke, keeping fully in mind the necessity for having combustion complete at the dead center.

The gaining of these advantages will be seen to depend upon so handling the mixture that it will burn with the utmost rapidity, and we may, therefore, determine upon the conditions that will attain this end.

In order that any liquid fuel may be available for gas engine use, it must be vaporized, and each particle of the gas must be associated with the quantity of air necessary for its combustion.

A carbureter is popularly supposed to vaporize the fuel and to form the mixture, but in the present state of its development it does little more than act as a proportioner, and to supply a certain volume of air to a certain quantity of fuel.

At the end of the inlet stroke the cylinder will contain some more or less perfect mixture of air and fuel vapor, a proportion of the fuel charge in liquid form, and sufficient pure air to form a combustible mixture when the liquid fuel is vaporized. Such a combination will burn but slowly, if it will burn at all, and it is on the compression stroke that we must depend for an improvement in the conditions.

Proper Mixing

VAPORIZATION of the fuel and the mixing of the gas with the air should occur before the charge is ignited, and if waste is to be avoided, the operation should be complete before the piston reaches its upper dead center.

The less efficiently this mixing effect is conducted, the earlier in the stroke ignition must occur, for slow combustion is the penalty paid for poor mixture.

With the mixture uniform in quality, the time required for the combustion of the charge does not alter to any practical extent with changes in engine speed, and for such a mixture, and at any engine speed, ignition should occur at such a point that combustion will be complete when the piston reaches the end of the stroke.

The necessity for accurate ignition will thus be clear, for obviously ignition earlier or later than the proper point will result in completion of combustion before or after the dead point is reached; equally obviously this results in the loss of efficiency. Given a number of ignition systems, therefore, the best will

*Abstract of a paper read before the National Gas and Gasoline Engine Trades Ass'n.

be that which can be relied upon to produce its spark at a certain point in the stroke with unfailing accuracy.

Electric Ignition

THE modern electric ignition system consists of 3 essential parts, which are: a source of current, a means of timing by which the spark may be produced at the desired moment, and usually a device by which the current is transformed into one of the proper voltage.

In a battery system producing jump spark ignition these parts are found in the battery, the induction coil and the timer, the first serving as the chemical source of current, the second converting the low pressure battery current into a current of sufficient pressure to break down the resistance between the points of the plug, and the third to control the instant at which the spark occurs.

To our sense, the time interval between the closing of the circuit by the timer and the appearance of the spark at the plug is too small to consider, and while one will admit that it may be measured, it will nevertheless appear so close to being instantaneous that it might well be considered so.

Let us look into the situation, however, and take account of the things that must occur between the closing of the circuit by the timer and the appearance of the spark at the plug.

Time Lag of Spark

WHEN the circuit is closed, the battery current finds an opportunity to establish itself in the primary winding of the coil, and as a result a magnetic field builds up in the core. When the field reaches a certain strength it draws the vibrator blade away from its contact to break the primary circuit, and the resulting collapse of the magnetic field reacts on the secondary winding, in order that the desired wave of high tension current may be produced.

The slightest delay in the performance of these functions will retard the instant at which the spark will occur at the plug, and this will be the result, for example, if the voltage of the battery drops a little, so that the current loses its ability to establish itself in the circuit, or if a fleck of grit prevents the timer from making contact until the moving part has passed part way across the contact plate. It is true that these delays are infinitesimal, but one must remember that the functions of a gas engine are performed with extreme rapidity.

At a crank shaft speed of 600 r. p. m. the piston will make a single stroke in 1/20 second. If ignition is arranged to occur when the piston has covered ¾ of the compression stroke, 1/80 second will remain in which the piston may move from the point of ignition to the dead center. In comparison with this brief interval, even so small a period as 1/100 of a second looms large.

Conditions for Efficient Action

THE efficiency of a battery and coil system depends, in the first place, upon an arrangement that will permit the core of the coil to become thoroughly magnetized, and for this it is necessary for the battery current to flow freely in the primary winding. This is possible with the ordinary arrangement when the engine is running slowly, but with an increase in speed the period when the revolving part of the timer will be in contact with the timer plate will be so brief that a sufficient flow of current cannot be secured to do the work properly.

In order to compensate for this, it will be possible to use a battery of high voltage, which will force the current through the coil in proper volume; but then the abnormal flow of current when the engine is running slowly will burn away the contact points, and rapidly exhaust the battery.

The condition of the vibrator blade also has its effect upon the instant at which ignition will occur, for the slightest decrease in swiftness will retard the instant at which the vibrator blade moves to the core; and another opportunity for irregularity is found in the possible condition that the vibrator blade will not have come to rest from the effect of one contact before the timer will have completed another revolution, and made contact for the second time.

Any interference with the flow of battery current through the primary winding of the coil will result in a decrease in the intensity with which the core is magnetized, and consequently in a decrease of the ignition current.

As a matter of fact, while a vibrator is of service when an engine is being started, it is of doubtful practical value for constant running.

If the ignition system is in good condition, and if the elements of the mixture are properly combined, ignition will occur with the passing of the spark that follows the first movement of the vibrator, and sparks resulting from any subsequent movements of the vibrator will pass in a region of burned gas, and will be useless.

If the system is timed in such a manner that the first spark will occur at the proper instant, the second and subsequent sparks will clearly be late, and if the conditions are such that ignition will be effective by these later sparks, there will be a natural loss of efficiency.

Far better results are secured with systems that produce but one spark to each contact of the timer, but it must be recollected that sufficient time must be allowed for the proper magnetization of the core. For instance, there are a number of systems on the market for which extraordinary claims are made for low consumption of battery current. These claims are undoubtedly upheld, but the construction of the apparatus is such that the time of contact is extremely brief, and the fact remains that the small volume of current that is permitted to flow through the winding of the coil is quite insufficient for the proper saturation of the core.

It is true that these systems produce sparks, but the sparks have little heating value. A system of this sort represents an attempt to secure something for nothing, for no one will deny that it is the quantity of current that flows between the points of a plug that marks the difference between feeble and vigorous ignition.

To effect ignition, a spark must come into actual contact with the molecules of the mixture, and the missing that frequently occurs with a thin spark may be traced directly to the fact that the spark is so small in volume that it does not make this required contact.

The more closely the ignition spark approaches a flame in character, and the farther away it gets from the thin, so-called static discharge, the more efficient will be the ignition.

The low heating value of a thin spark makes it necessary to advance the point of ignition considerably beyond what would be required for a spark of high heating value, and under such conditions the sav-

ing in batteries is more than balanced by the greater consumption of gasoline due to the heat losses resulting from the longer exposure of the burning charge to the cylinder walls.

Make and Break

IGNITION by the mechanical make-and-break of a low tension current, or the wipe spark system, as it is frequently called, depends upon the closing of the battery circuit through a low tension or primary coil, the spark occurring at the point in the stroke at which the circuit is subsequently broken.

The necessary apparatus includes a cam and tappet rod, a moving member passing through the cylinder wall, and such springs as may be required. The igniting ability of the resulting spark is conceded, but difficulties are present in lag in the mechanical as well as in the electrical parts, and in the complication of design and manufacture. The opportunities for losses of compression through the cylinder wall joints, the noise, the frequent adjustments that are required to compensate for wear, and the very great difficulty of adjusting the individual igniters to act in the synchronism that is necessary for efficiency, are against its use.

No system of ignition will operate with the accuracy that is essential in securing of efficiency, if it requires the electric current to do any work other than the actual formation of the spark at the plugs. If the current is required to build up a magnetic field, or to force its way through a coil, there is no certainty that conditions will remain constant, and in consequence variations in the instant at which the spark will appear are certain to occur. This will invariably be the case when a coil of the usual type is employed, whether the source of the current that flows through the coil is a battery or any form of mechanical generator.

In general the design of ignition systems provides for the making of a circuit which permits the current to establish itself and finally to produce a spark. The ill success of these systems is due to the variation in the lag between the closing of the circuit and the appearance of the spark.

Lag will be entirely obviated if the arrangement is such that the spark is produced when the circuit is broken instead of when it is made. To secure this result, the circuit is closed during the portion of the cycle that precedes ignition, and it is at this time that the current is permitted to establish itself in the circuit. At the instant when ignition is required, current is therefore already present, and the production of a spark will depend upon the breaking of the circuit. With such an arrangement absolutely accurate ignition will be assured, for the lag will be entirely eliminated.

Magnetos

THIS arrangement is characteristic of all Bosch magneto and battery systems, for in this apparatus the current is fully established by the time ignition is required, and it is clear that by this method the most accurate possible results may be obtained.

The word "magneto" designates a generator of electric current in which the field magnetism is produced by permanent steel magnets.

Magnetos are produced by a number of makers, but it is of more than passing interest to learn that the company, which first adapted the magneto to the ignition of gas engines, has found it necessary to produce more than 220 distinct types, in order to supply the requirements of the manufacturers of gas engines. These types cover the whole range of low and high tension ignition, but inasmuch as the high tension system is easily applied, and produces most satisfactory results, it follows that more of that class are used than of the other, although it must be added that for certain types of gas engines, low tension ignition is essential.

For all practical purposes, a magneto may be said to consist of the same essential parts as a coil-and-battery system, for it includes a timer, a source of current, and a means by which the current may be transformed to acquire the pressure necessary to break down the resistance of the spark plug gap.

The battery operates as a chemical generator of electric current, but in the magneto the source of current is mechanical, and current is produced by the rotation of the armature in a magnetic field.

It will be observed that the high tension current produced in a coil results from changes in the strength of the magnetism of the core, due to changes in the flow of battery current, whereas in the magneto the magnetic field is constant.

The arrangement of the parts of the magneto is such that the relation of the armature to the magnetic field is reversed twice during each revolution, and these variations result in the production of electric currents in the armature windings.

The intensity of any current is produced by changes in magnetic strength, and also with the rapidity with which they occur.

When the armature of a magneto is revolving at slow speed, these changes, of course, occur more slowly than will be the case when the armature is speeded up. In consequence a magneto will give a more intense current at high speed than at low, and this, it will be observed, is contrary to the action of a coil.

With the usual coil-and-battery system the speeding up of the engine will result in the reduction of the time during which the battery current may flow through the primary winding, and in consequence, in a reduction of the intensity to which the coil is magnetized.

To one who has worked with the coil-and-battery system, the magneto at first seems difficult to understand, for instead of giving a constant and steady flow of current, the current developed by it is constantly changing in strength. Two or more times in each revolution it is at zero, and correspondingly, two or more times in each revolution it reaches a maximum at which it is capable of producing ignition.

This fact explains the necessity for driving the magneto positively with the engine, and for setting the armature in such relation to the crank shaft that the relative positions of the 2 are constant. The necessity for operating the circuit breaker in absolute synchronism with the piston also requires the maintenance of positive relations between the magneto and the crank shaft.

A true high tension magneto produces its own jump spark current, and is entirely self-contained, the only wiring consisting of one cable from the magneto to each spark plug.

When the armature of a magneto is rotated, a current is produced in its winding, and as has been stated, this current rises to a maximum 2 or more times in each revolution.

The best results will naturally be attained if it is the maximum current that is utilized for ignition purposes, and this is provided for by the timing arrangement with which the magneto is fitted.

Timing with the Magneto

THE timer or interrupter takes the form of a simple contact breaker that revolves with the armature, and which is so arranged that it provides a short and easy path for the current when its platinum points are in contact.

By arranging suitable blocks or cams, the interrupter may be made to open and to break this circuit at any desired point in the rotation, and it is, of course, necessary only to set these blocks in such relation that the break will occur during the period when the current is being produced.

In some types of magneto the wave of current produced rose abruptly to a peak, and then died away gradually. As a result a spark could only be obtained at low speeds by utilizing the peak of the wave, and this point was known as the advance position.

In the best known high tension types a spark suitable for ignition can be obtained in the advance position at from 55 to 70 r.p.m., and in the full retard position at 180 r.p.m. At speeds above 180 r.p.m. a spark would be produced at any point in the range.

The most careful study has been made of the conditions that would permit a reduction in the speed necessary to produce a spark in the fully retarded position. As a result of the experimental work that has been carried on, a type of magneto has been developed which makes it possible to secure an ignition spark at as low or even lower speed in the full retard than in the full advance position. A magneto of this character will permit the starting of the engine with the spark fully retarded and with slow cranking, and operation on the magneto is permitted at the lowest speeds at which mixture will be drawn into the cylinder.

One demand that has been made by the manufacturers of gas engines has been for a combination magneto-and-battery system—the magneto to be used for the normal operation of the engine, and the battery to be called on for starting purposes, or for continuous operation, if it is desired. With one arrangement that has been made, starting is possible by the pressing of a button—if the cylinder contains gas—for this produces a vibrator spark in the cylinder that is on the firing stroke.

It is of interest to note, however, that the European manufacturers of automobiles and marine engines use the magneto as the sole source of ignition with practical unanimity, as for instance in France 95 per cent of the automobiles turned out have no battery system, and depend absolutely and solely upon the magneto.

The Spark

WE speak of a magneto spark, but as a matter of fact the ignition is caused by an arc or flame that forms between the electrodes of the spark plugs.

An examination of the spark produced is of interest, and will be found to consist, in the first place, of a thin white thread passing between the electrodes and around this is a violet flame or halo. A curious effect is seen if a current of air is directed against this spark, for the flame will be blown to one side much as a candle flame will be blown by a draft of air. The white thread, however, will continue unchanged, and this experiment is evidence of the fact that the spark consists, as has been said, of two distinct parts.

Furthermore, the spark is not instantaneous, that is, it has an endurance. The spark that is produced from the vibrator coil will be the result of a single discharge of current, but the magneto spark consists, in the first place, of a discharge of this character, and followed by a discharge of current of low voltage but high amperage that resembles in appearance and action the low tension make-and-break spark.

The high pressure discharge may be considered to be that which breaks down the resistance between the points of the plugs, and which is followed by the rush of low pressure, high amperage current that carries the heat value, and effects the ignition of the mixture.

The complete absence of lag that is characteristic of some magnetos makes it possible to operate an engine efficiently with far less advance than is required by any other system, and ignition occurs so close to top center, that excellent results may be obtained without varying the ignition point to correspond with the speed.

This feature is taken advantage of by many engine manufacturers who are enabled to suppress the spark control connections, and who depend on ignition at a point sufficiently close to top center to make it absolutely safe to crank the engine.

A simple series of tests will be sufficient to prove that the full power of the engine can be developed with less advance on the magneto than would be possible with any battery system, all this is equivalent to saying that the use of a magneto will produce greater efficiency than is possible to attain with any other system of ignition.

Double Ignition

THE system of a magneto provided with 2 distributors, and which furnishes ignition at 2 points in each cylinder. If the 2 spark plugs are close together, little difference will be noted in ignition by this system over the usual system of ignition at one point, but with the spark plugs properly located at appropriate points in opposite sides of the combustion space, it will be seen that ignition will occur at 2 points from which the flame will spread.

It stands to reason that less time will be required for the speed of the flame from 2 separate points than from one single point, and that the time required for complete combustion will be reduced.

Experimental work has borne out this theory, and it has been proved many times in practical work that the use of the 2-point ignition system will result in as great a power output with ignition occurring at top center as would be secured by single point ignition at the most favorable point of advance.

This system was applied to a number of racing cars in the automobile road races of the past season, and from 3 to 5 miles an hour was added to the speed of the cars by the simple changing of the ignition system.

GEO. Q. PALMER, formerly vice-president of the Alberger Condenser Co., New York City, has been made president of the Alberger Condenser Co. and the Alberger Pump Co., to take the place of Mr. Louis Ross Alberger, whose death is announced in another item. Mr. Palmer is succeeded as vice-president in the Alberger Condenser Co. by D. H. Chester and in the Alberger Pump Co. by W. S. Doran.

THERMOSTATIC CONTROLLING SYSTEM

By Charles Mandeville

INSTALLATIONS of thermostatic systems for controlling the action of steam valves have become so common features of first class work, that some information on the working of a thermostatic system may be acceptable to those who depend upon the successful operation of the thermostat for relief from labor, and, I may add, for freedom from complaints and "cuss words."

The system which I describe is the Johnson system, as this system is widely used; there are, however, other excellent systems on the market. It is a

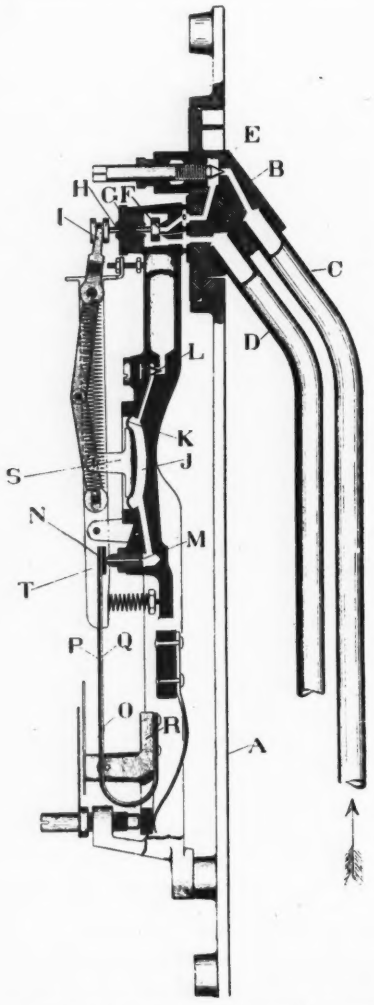


FIG. 1. SECTIONAL VIEW OF JOHNSON'S THERMOSTAT

method of controlling the opening and closing of valves or of dampers at such intervals as to maintain an even temperature automatically, using compressed air as the motive power. A receiver is supplied with air from an air compressor and is kept automatically under constant pressure of about 15 lb. From the receiver a system of piping extends to the different wall blocks to which the thermostatic instruments are attached.

The thermostat, from which the system takes its name, depends for its action upon the scientific fact that all metals expand when they are heated and contract when they are cooled, also that different metals expand or contract different amounts for the same change of temperature.

The expansion of brass is 0.000009 and of steel is 0.000006 per unit of length per degree Fahrenheit. This statement is the key to the entire thermostatic problem. If we have a piece of brass soldered to a similar sized piece of steel, the brass side of the strip will expand more than the steel side and consequently the strip will be bent or warped slightly. This movement, while so slight that it must be measured in ten-thousandths of an inch, is still enough to open or close a port the size of a pin hole in the thermostat, and by so doing to operate, through the medium of compressed air, the valves controlling the action of the apparatus to be regulated.

Details of Operation

WALL blocks, to which the instruments are attached, must be set in such a position as to expose the instrument to the general average temperature of the room whose temperature is to be maintained at the desired point. The receiving wall block has an inlet port B connecting with the air receiver and fitted with a plug valve E, so that the air supply can be shut off if it is desired to remove the instrument from the wall block. There is another hole or port in the block, which opens into a pipe leading to the valve damper or other fixture to be controlled. The thermostatic instrument is fastened to the wall block with a rubber filter gasket between the two. This gasket has felt strainers covering the port openings.

From the valve E the air is led by a crooked passage to the air valve F. When in the position shown the air can go no further, the valve, however, is attached to the stem G which passes through the outlet H and is operated by a system of levers from the diaphragm K. If F is moved up to the inside opening of H it will close the opening and allow the air to pass directly from B to the pipe D leading to the control valve or damper, which will then close.

When the valve F is again closed the air from the diaphragm controlling the steam valve is allowed to pass through the outlet H, thus opening the steam valve to the radiators.

The sensitive and fundamental part of the apparatus is that which controls the valve F. Beneath this valve is a tube filled with absorbent cotton which is in constant communication with B through a port and from this tube air passes to the diaphragm chamber through a small valve L, accurately adjusted to suit the demands of the installation. The outlet for the air from beneath the diaphragm is through the port M, which is very small but larger than the opening at L and thus, when open, will allow the pressure in J to decrease and the diaphragm K to move to the right.

It will now be seen that the operation of the apparatus depends upon the opening and closing of the port M, this is done by means of the valve N which is normally kept in the closed position. N is attached to the U-shaped metallic strip O which

is fastened rigidly to the block R at one end, but is free to move the valve N at the other. The strip O is composed of steel and brass, soldered together with the brass on the concave side of the strip. Brass, being more sensitive to temperature changes, will contract and expand more than steel, thus closing the valve when it becomes cool and keeping it open as long as the temperature is above that desired.

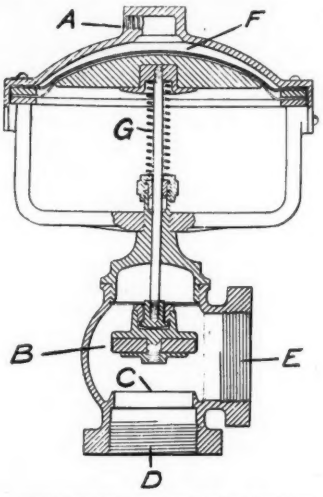


FIG. 2. CROSS-SECTION OF DIAPHRAGM VALVE

When N is closed the pressure in J rises forcing the diaphragm K to the left which through a system of quick acting levers closes the valve F. This allows the radiator valves to open and the temperature will then rise. Above the desired temperature the valve N opens and the reverse operation takes place.

Radiator Diaphragm Valve

THE control valve which is placed on the radiator or other apparatus to be controlled is just an ordinary valve with a special form of bonnet on it. This

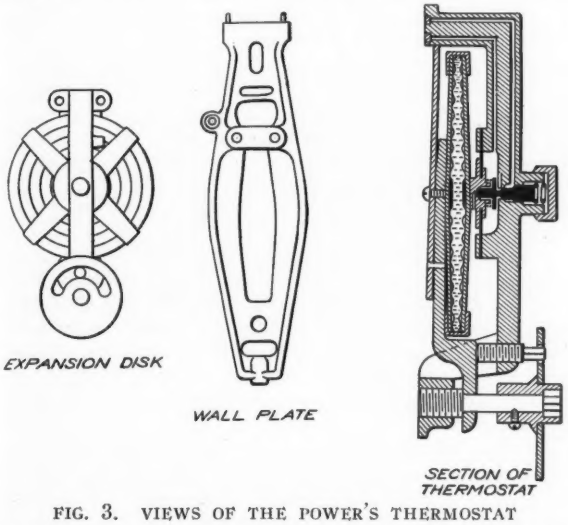


FIG. 3. VIEWS OF THE POWER'S THERMOSTAT

bonnet holds a light iron frame to which a rubber diaphragm reinforced with and strengthened by a disk of felt is fastened by means of small screws, and the joint between the rubber and the metal is made tight with a treatment of shellac and asphaltum. At the top of the iron frame is an outlet tapped for a small air pipe. This pipe is extended to the pipe D on the wall-block to which the thermostat is fastened. A spring is fitted around the valve stem to help to open it. The valve is so set that the steam pressure comes underneath it.

The thermostat lets in air from the compressor to the valve whose diaphragm is made sufficiently large that the pressure of about 15 lb. of air will be sufficient to overcome the steam pressure acting underneath the steam valve and to close it. Then when the valve F on the thermostat shuts off air from the compressor the pressure under the steam valve disk, acting together with the spring fitted around the valve stem opens the valve, forcing the air through the outlet H of the thermostat. Packing in the

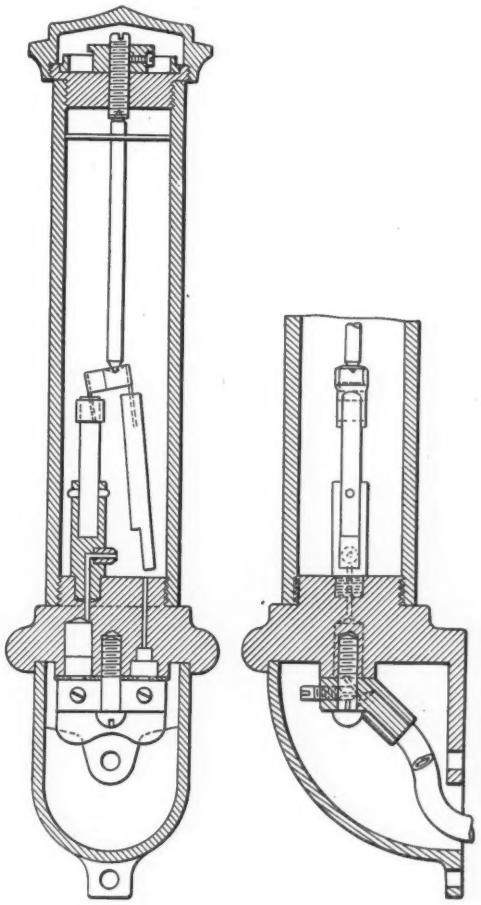


FIG. 4. THE NATIONAL THERMOSTAT

stuffing-box around the valve stem must be kept soft and pliable so that there will be no sticking or binding.

Attendance

ONE great fault of this system is occasioned by the fact that the rubber diaphragms used will harden. They must be watched closely for this fault and when they commence to lose their elasticity they should be renewed. The compressed air and the heat seems to vulcanize them; their life under normal conditions may be from 2 to 3 yr. When placed in localities where they are subject to high temperatures their period of service is greatly decreased.

The use of oil for lubricating the air end of the compressor is disapproved of as it seems to have a

tendency to rot the rubber. Air leaks are the great dangers in this system and all precautions must be taken to guard against them. The rubber filter gaskets on the instrument sometimes become stopped with dirt or with moisture as does the absorbent cotton in the tube leading to valve L. The rubber diaphragm K like all such diaphragms used elsewhere must be renewed when it has lost its elasticity. It often hardens or cracks.

Small particles of dirt or dust lodged in parts of the system will of course cause faulty action or stoppage of service. It may be said here, do not use oil on the thermostatic instrument's joints or it may cause faulty action by collecting dust and clogging.

The receiving tank for the air should be fitted with a blowoff cock at its lowest point and this should be opened regularly to let out any dirt or moisture which may collect.

The service of compressed air has also been applied to the controlling of valves and of dampers independently from thermostatic control. The air-controlled valve Fig. 2, may have air let on or off by means of a 3-way cock so as to control the operation of any valve at a distant point. This method is used, for example, in steam-heating lines, for shutting off entire risers. A switchboard or valveboard placed at some convenient point allows any riser to be shut off at will, while at the same time the radiators upstairs may be controlled by separate instruments in each room.

In addition to the Johnson system, as described above, there are several other systems of thermostatic control based upon similar methods of operation, but having some difference in construction of parts of the controlling instrument.

The Powers instrument employs a double disk of corrugated metal, soldered at its edges so as to form an air-tight closed vessel. This disk is filled, before it is finally closed, with one of the several known liquid chemicals which boils at the temperature required to be maintained. The chemical used gasifies or condenses when a very slight change of temperature occurs and in so doing it causes the bulging out or the flattening movement of the metal disk which is employed to actuate a small pilot valve, which in turn, lets air on or off from the radiator valve or other apparatus to be controlled.

In the National system a tube or cylinder of hard rubber is employed in place of the metal disk. This vulcanized rubber tube expands or contracts as the temperature in its vicinity changes and this movement operates the control valve through a system of levers. The movement controls a port opening as in the systems described, to let compressed air on or off the apparatus to be controlled. The use of rubber diaphragm valves, actuated by the pressure of air and of springs, and the varying of range of temperature by increasing or decreasing the distance of the expansion piece from the pilot port is employed in all of these systems.

SOURCES AND METHODS OF PRODUCTION OF LUBRICATING OILS

By W. A. Converse*

PHYSICAL properties of the various crudes has been more or less touched upon previously, but can be thoroughly appreciated only with samples for visual examination. They vary, however, in gravity from 9 to 60 deg. Beaume; in color from light amber or lemon to jet black; in base, from paraffin to asphalt, including mixtures of these bases in the same oil, as previously alluded to; in odor, from those which are rather pleasant to those which are very obnoxious; in viscosity, from extremely thin, as low in viscosity as kerosene oil, to those practically semi-solid.

As an illustration of how the oils from even the same field, or at least coming under the same class, may differ, one known in commercial oil circles as Butler crude, which is obtained in the vicinity of Mansfield, Ohio, near the town of Butler, from which it derives its name, is of a very light amber or straw color, transparent, has a gravity of 60 deg. Beaume and burns at ordinary temperature; it is readily ignied with a match, as would be the case with gasoline. The well from which it is obtained is 2,700 ft. deep, entering but 18 in. in Clinton sandstone. The well at the time it started gave a yield of 200 barrels daily; the quantity has decreased to a considerable extent, but did not get below 175 barrels daily for some time.

A distillation test made on this oil gave a yield of 54 per cent gasoline and 44 per cent of burning oil or kerosene, leaving but 2 per cent of residue. The products obtained from this crude oil are of very high quality, the other type being what we know as Franklin (Pa.) crude, which is of very dark color (nearly black), having a gravity of 28 to 29 deg. Beaume, a burning point of 290 deg., and being several times more viscous than the Butler crude. The difference also extends beyond this. Upon distillation it yields practically no gasolene and but a small amount of naphtha, and only from 8 to 10 per cent of kerosenes, the balance entering into the manufacture of lubricants.

At this point the writer deems it advisable to make some allusion to the composition of crude oils or petroleums, and for convenience we will consider them under three heads: viz., chemical, proximate and commercial.

Chemically petroleum is made up of carbon and hyrogen, containing varying quantities of sulphur and nitrogen. Ignoring the sulphur and nitrogen present, the relative proportion of carbon and hydrogen would be 85 per cent of the former and 15 per cent of the latter. The sulphur content varies from a trace to approximately 3.5 per cent; nitrogen from none to 1 per cent.

Proximately it consists of chemical compounds of carbon and hydrogen which by the chemist are classified into several groups, the more important of these being designated as paraffins, oleofins, etc.

To the presence of these chemical compounds in varying proportionate amounts is due the difference in the appearance and, to some extent, the odor, although the odor is to a much greater extent attributable to sulphur compounds.

*Chemical Director Dearborn Drug & Chemical Works, Chicago.

The commercial composition of petroleum is that which has to do with the different products of commercial value which can be produced therefrom, such as benzine, naphtha, kerosenes, lubricants, paraffin wax, etc. As stated previously, some crudes, such as those from the California field, produce no benzine or naphtha and only 7.5 per cent of kerosenes, 47.5 per cent of very inferior lubricating distillates and 45 per cent asphalt; others, such as some of those from the Appalachian field, especially those from Pennsylvania, yield approximately 14 per cent of benzine, 6 per cent naphtha, 45 per cent kerosene, 15 per cent lubricating oil distillates, 15 per cent cylinder stocks or oils, 2 per cent paraffin wax, and 3 per cent loss, these percentages being based on the original crude. These 2 represent the extremes, and we have all the other gradations coming in between them.

Purifying

PROCESSES for the conversion of crude petroleum into marketable products and such as to be available for the many purposes for which they are used, vary in some respects greatly, in others much less, dependent on the physical and chemical properties of the crude petroleum being handled. In some cases it is "steamed," which consists of passing live steam through the body of crude contained in reservoirs or tanks for the purpose of removing as far as possible the sulphur compounds present. Very little of the sulphur other than that present in the form of sulphuretted hydrogen can be removed in this manner.

Others are submitted to acid treatment for the removal of certain hydrocarbon compounds which constitute asphaltic or tarry matter. These treatments are applied before the crude goes to the still. Other previous and special treatments are in vogue to some extent in the handling of crudes of peculiar nature in order to fit them for distillation and further refining.

Time and space will not permit at this time of going into a detailed description of each of the 2 general methods of distillation and refining, even so far as they have to do with the lubricating products obtained from petroleum. Therefore, suffice it to say that 2 general methods of distillation are in use at the present time.

Since we are not here interested in the products of crude petroleum, other than those used as lubricants, it is unnecessary to enter into a description of the first stages of the process of distillation and refining, as, up to a point at which all of the lighter hydrocarbon oils, viz., benzine, gasoline, naphtha, and at least a greater portion of kerosenes, are removed, they are the same.

Distillation

THESE 2 processes are known among oil refiners as Dry or Destructive Distillation, and Steam or Wet Distillation. In the former the crude is placed in stills holding approximately 500 to 750 barrels, and the distillation carried on until the light oils above referred to are entirely removed, leaving in the still, as a residue, a thick substance known to refiners as "tar." This is then placed in a smaller still, commonly known as a tar-still, fired very strongly, and all oils possible distilled over in this manner, leaving in the still as a residue petroleum coke, which is virtually 98 to 99 per cent pure carbon, and very much resembles ordinary coke, but is much more porous.

The oils passing over are separated into several different portions, according to gravity, in order to adapt them to further redistillation, refining, etc., and conversion into marketable products. These several distillates are then frequently redistilled to reduce to the desired gravity; and all of them are treated in agitators with sulphuric acid for the purpose of removing the tarry matter, which is present to a large extent in oils manufactured by the process of dry distillation. After being treated with the sulphuric acid, they are allowed to stand at rest in the agitators until the sulphuric acid containing the precipitated tarry matter, due to difference in gravity, settles out. This is drawn off from the bottom of the agitator, and the oil remaining therein is then treated with a weak solution of alkali (usually caustic soda), for the purpose of neutralizing any trace of acid left in the oil.

You will readily see that in case of carelessness at this step in the process it would be easy to permit an excess of free acid to remain in the oil, which would much impair its value as a lubricant on any metallic surfaces. The oils manufactured by this process are commonly known in the market as Paraffin Products.

Wet distillation, or distillation with steam, is carried on in a materially different manner. Before the kerosene oil is all driven off, superheated steam is injected into the bottom of the still in such a manner as to effect a rapid agitation of the oil contained therein, bringing to the surface new portions of the body of oil, and permitting a more rapid distillation at a much lower temperature than would be possible in the case of dry distillation.

The steam, passing through the space in the still above the oil, out through the condensers, assists mechanically in carrying the vapors of the oil through the latter, thereby facilitates the carrying over of the lighter distillates, such as, after being properly refined, are suitable for engine and dynamo lubrication, at a very much lower temperature than would otherwise be possible, which adds largely to the quality of the product.

This distillation in connection with steam is carried on until a sample of the residue, drawn from the still, shows the desired fire test for a specific cylinder stock. When this point is reached the still is closed down and the residue, when sufficiently cooled, is withdrawn, and, when further refined, becomes the dark-colored cylinder stock on the market.

Distillates obtained in this process are separated by gravity, as before, and are when necessary redistilled (reduced), finally chilled and pressed to remove paraffin wax, then debloomed by submitting to action of atmospheric conditions for anywhere from 10 to 30 days, finally filtered through bone charcoal or Fuller's earth to the desired color and transparency.

The residue obtained in this process, instead of being coke, as was the case with dry distillation, is, as stated before, that portion used for the production of steam cylinder lubricants. After being removed from the still, it is strained through sufficiently fine mediums to assure a complete removal of any foreign matter which could have entered the still in suspension in the crude oil. In the oil fields, however, the crude oils are stored for varying lengths of time previous to submitting to distillation, and the greater portion of any suspended matter, like clay, sand or water, which might be present as these oils come from the well, is largely settled out by gravity while standing in storage tanks.

NEVER HUNT trouble, even in a power plant; shoot it.

TYPICAL SMALL CENTRAL STATION

By P. A. Boyd

WOOSTER Electric Co., of Wooster, Ohio, has a small plant which typifies both in its history and in its business the average small central station in the United States. The company was organized in 1885 as the Wooster-Schuyler Electric Co., and in 1890 a stock company was formed as the Wooster Electric Co., the stock being owned by Wooster people.

At the time, the plant consisted of one 50-kw. Thomson-Houston generator. In 1900 a 75-kw. Fort Wayne single-phase generator was installed to replace the Thomson-Houston set. From time to time small generators were added to the plant to take care of additional load as business grew. In November, 1909, a 75-kw. Westinghouse alternator was substituted and in March 1910 a 250-kw. Westinghouse alternator was added to the plant.

Wooster is a college town and does not boast of many manufacturing industries, nevertheless the company has found it profitable to provide a 220-volt power service in addition to the 110-volt lighting service. The power circuit load averages about 25 kw. during the day and has doubled since the installation of the large generator in the spring of 1910. The power load consists of small machine shops, blacksmith shops, harness shops, bakeries, ice cream freezers, plumber shops, and one garage, also a few house pumps.

Lighting current is supplied for residences, and the plant has in addition a series circuit of 96 arcs for street lighting, direct current being obtained by means of a Cooper-Hewitt mercury rectifier.

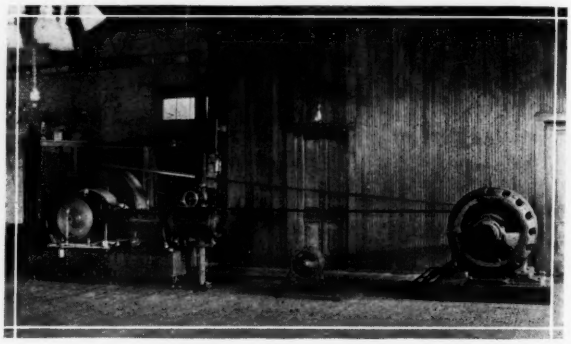


FIG. 1. RUSSELL ENGINE AND 75-KW. WESTINGHOUSE GENERATOR IN THE WOOSTER PLANT

Distribution is made on the lighting and power circuits by means of 2200-volt 3-phase currents. There is a separate line supplying the Wayne County Children's Home 2 miles distant and a line supplying the Wayne County Infirmary 1.5 miles distant.

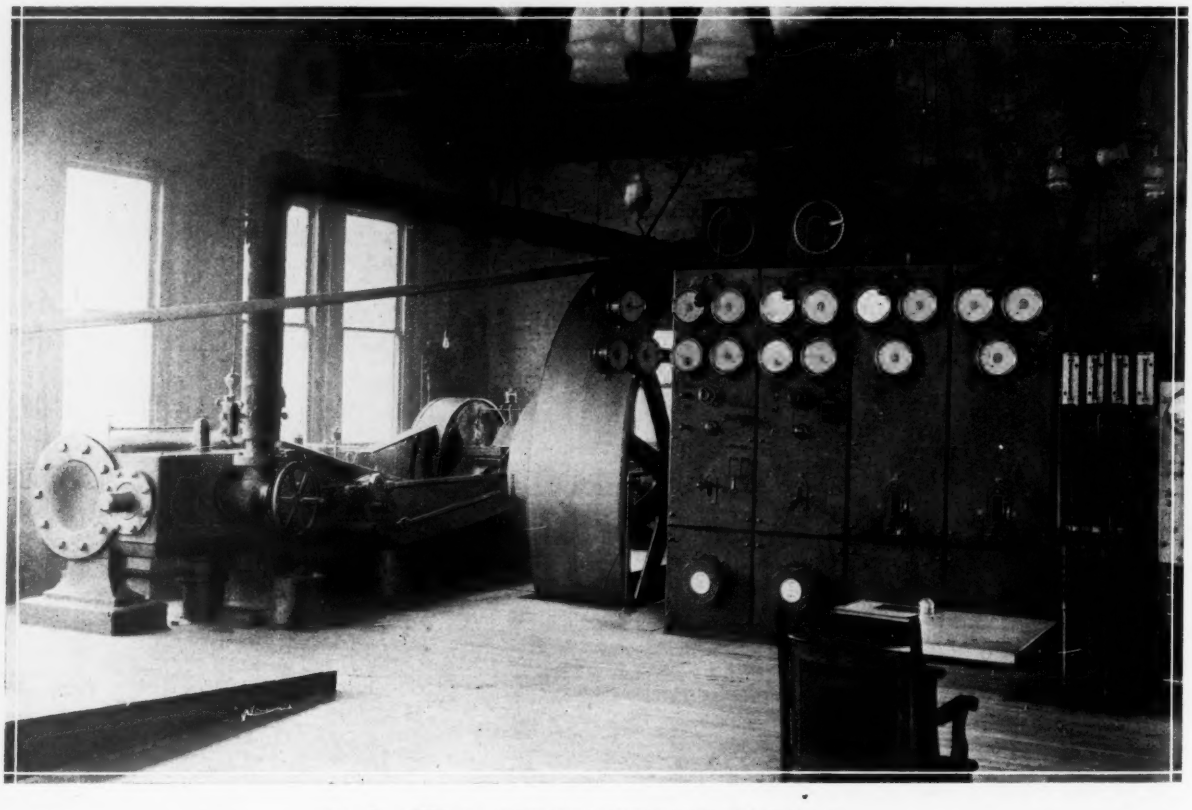


FIG. 2. 250-HP. BUCKEYE ENGINE AT WOOSTER, O.

The power house building is of brick and has a slate roof with a total floor area of about 70 ft. square, divided into an engine room, 2 offices and the boiler room.

In the boiler plant are 2 150-hp. Russell boilers, hand fired, using city water and Massillon slack coal.

Steam is carried to the 75-kw. set by means of a 4-in. pipe and to the 250-kw. set by means of a 6-in. pipe.

The 75-kw. set runs at 900 r.p.m., developing 2400-volt, 3-phase, 60 cycle current. The generator is belted to an 80-hp. Russell automatic cutoff engine installed on a stone and brick foundation, the generator being set on framework.

The 200-kw. set consists of a 200-kw., 2400-volt, 3-phase, 60 cycle generator running at 600 r.p.m., of the same type as the 75-kw. It is belted to a 250-hp. Buckeye engine with automatic cutoff. The engine foundation is of stone and the generator foundation is of wood on brick set in cement. Both engines use steam at 100 lb. pressure.

Wiring between the generators and the switchboard is all concealed under the flooring. The switchboard has 4 panels built by the Westinghouse Electric & Manufacturing Co., 2 generator and 2 feeder panels. The alternating current voltmeters and a synchroscope are mounted on a frame bracket at one end of the board, an ammeter in each leg of each circuit on the panels and the field rheostats are mounted above the top of the board. All circuits entering the building are protected by Westinghouse lightning arresters.

To carry the day load the 75-kw. machine is used and the 250-kw. machine for the night load, but during the heavy winter load both machines are sometimes required.

SELLING LIGHT, HEAT AND POWER IN MILWAUKEE

THE Wells Power Co. of Milwaukee, Wis., in a recent report on the operation of its 2 powerhouses for the year ending July 1, 1910, gives a figure for the total kw. hr. sold of 1,275,455 and a total generated of 1,561,410 kw. hr. This showing is particularly noteworthy in view of the insignificant beginning of this enterprise. Originally a group of contiguous property owners in the heart of the business section of the city pooled interests to build a small plant in the basement of a business block to supply light, heat and power to the members of the syndicate, each of whom was to bear a portion of the cost of the plant.

Later on it was found possible to dispose of the surplus energy generated in this plant to surrounding business blocks and soon the plant was being operated to its maximum capacity. The Wells Power Co. was then formed to take over this plant and a newer and larger plant was planned in a nearby building, to operate in parallel with the old station and to enable the power company to establish itself on a much larger scale. As the company had always made it a policy to sell steam for heating as well as electric power, the question of proper design for the new station in order that its efficiency under the conditions that existed with this company should be as high as possible, was particularly important.

The station was built from designs made by the engineering firm of D. C. & Wm. B. Jackson, of Chicago and Boston. It was located in the basement of the new Stevenson Building, at the corner of Mason and Milwaukee Streets and but a short distance from the Wells Building, which contains the original station. The 2 stations are connected electrically and by steam mains so that parallel operation is a simple matter.

The main equipment of the new station consists of 2 Babcock & Wilcox and one Edge Moor 508-hp. boilers fired by Jones underfeed stokers and 2 Allis-Chalmers, cross-compound, vertical Corliss noncondensing engines direct connected to 2 Bullock 500-kw., 250-volt direct-current generators running at 100 r. p. m. Steam pressure carried is 150 lb. and the average pressure in the heating mains into which the engines exhaust is 2.5 lb. The engines are especially designed to operate noncondensing and their efficiency falls off but little from atmospheric to 4 lb. back pressure. During the summer the exhaust is carried to an exhaust head on the roof and discharged to the atmosphere, as it was impossible, due to the plant's location, to provide a condensing outfit for the summer.

It is a part of the policy of this company to accept no contracts to furnish exhaust steam heating without the accompanying lighting contract and in this way

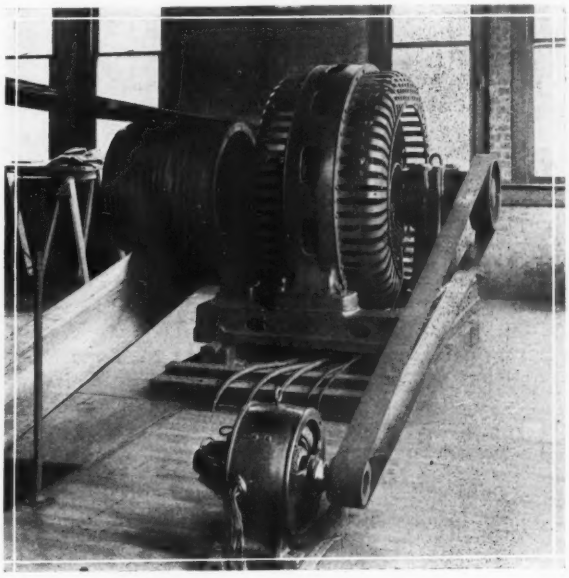


FIG. 3. 200-KW. WESTINGHOUSE GENERATOR AND EXCITER

it has been possible to keep the 2 loads well balanced and to insure the maximum efficiency of production. The load factor of the main units is kept at a high figure by taking up the fluctuations of load on the smaller units in the old power station.

At the present time this plant is supplying customers in an area comprising 2.5 sq. mi. in the center of the city and it is confidently expected that the rapid increase which has taken place in the past will be continued. Accordingly the engineers made provision in their designs for more than doubling the present capacity of the Stevenson Building power plant and what was originally started as an isolated plant on the community scheme bids fair to develop into a central station having considerable influence on the future development of the light and power situation in Milwaukee.

E. F. LAKE, formerly steel editor of the American Machinist, has severed his connection with that publication and will act as special correspondent and consulting metallurgist, giving expert advice on metal alloying, casting, welding and testing of metals. He will be located at Avenue B and 47th St., Bayonne, N. J.

DETAILS OF POWER PLANT DESIGN

BOILER FEEDING AND CONDENSER EQUIPMENT

By Charles L. Hubbard

ALL high-pressure boilers should be provided with duplicate feed apparatus. In office buildings and similar plants where there is a heating system connected with the outfit, the boilers are ordinarily fed by way of the receiving tank and return pumps. In this arrangement the returns from the different parts of the heating system, such as direct and indirect radiators; main heaters or blast coils at fans; drips from high and low-pressure piping which are free from oil, are trapped into a vented receiver, and from here pumped back to the boilers.

Fresh water which is required to replace that lost by the various wastes is drawn into the receiving tank, and from there pumped into the boilers with the return water. This cold water supply may be admitted to the tank either by a hand valve or by an automatic boiler feeder. In the former case the admission valve should be opened just enough so that the stream flowing continuously will maintain a constant level in the boilers, rather than to admit large quantities of cold water intermittently. A hand valve in the supply pipe can usually be set to maintain the water line very closely when the plant is running under uniform conditions.

In the case of an automatic feeder the water is admitted as required by means of a float valve operated from a closed chamber connected with the boilers, and having the same water level. The distribution to the different boilers is adjusted by means of hand valves in the individual supply pipes. Spring checks are preferable to the ordinary form of swing check for use in boiler feed pipes where the water is supplied by a pump, as the valve being held in place by a light spring is prevented from beating against the seat between the strokes of the pump.

Use of Injectors

WHERE feed pumps are employed as above described the duplicate or reverse feed usually takes the form of an injector or inspirator. An injector has the advantage of compactness and simplicity, having no moving parts when in operation, except a light check in certain forms. The successful operation of an injector depends upon the steam pressure, height of lift and temperature of the feed water, and the proper combination of the conditions must be obtained in any case. The range of the stationary type of the Hancock Inspirator under different conditions is as given in Table I.

Table I. Range of lift for Hancock Inspirator, Stationary Type

	Minimum steam pressure for	
	Feed-water	Feed-water
Lift	Cold	100 degrees
5 feet	15 pounds	15 pounds
10 "	20 "	30 "
15 "	25 "	40 "
20 "	35 "	45 "
25 "	45 "	50 "

Special inspirators are made which will operate on less than 15 lb. pressure. When used on a short lift they will take feed water up to a temperature of 150 deg. F., with steam pressures from 80 to 150 lb.

As cold water is usually brought to the injector under city pressure, there is no difficulty in adapting this type of apparatus to the conditions of office building work.

Feed Pump

THE regular form of direct steam pump is commonly employed for boiler feeding. Although wasteful in the use of steam they have the advantage of being operated automatically by means of a float and balanced valve, while power pumps run automatically at the same speed, and regulation must be by means of bypass valves. When used in connection with a heating system, the exhaust from a pump can be purified and turned into the general heating main so that the steam consumption is not an important matter.

Decision upon the best type of steam pump to use, whether piston or plunger, will depend largely upon local conditions. If the water is pure and free from grit, the former is generally employed, but for gritty water, and where there is considerable wear on the internal parts, the plunger is the better type as the bushing in which it moves is more easily replaced than the cylinder lining.

For high pressures, above 125 lb., the outside packed plunger is recommended, as leaks are easily detected and packing tightened or renewed from the outside. Ordinarily, 2 pumps should be employed, of such size that one running at a piston speed not exceeding 80 to 100 ft. a minute will do the entire work. This allows a low speed when both are working.

Some engineers prefer to make both pumps of such size that one will do the work easily, and run them alternately, thus having a reserve pump available at all times. This is a good arrangement in combined power and heating plants as an injector is commonly used only for feeding fresh or cold water to the boilers and not for returning the condensation from a heating plant; this, in general, is too hot for an injector to handle easily.

Heating the Feed Water

FEED-WATER heaters are required for summer use when the heating plant is shut down and the exhaust thrown outward, and in special cases where the exhaust is in excess of the heating requirements, even in the winter time. If all the exhaust steam can be condensed in the heating system and the condensation purified of oil and returned to the boilers, there is, of course, no advantage to be gained in using a feed-water heater, as the small amount of cold water required can be warmed by mixing with the return water in the receiving tank.

Open or closed heaters will depend somewhat upon the quality of the feed water and the preference of the designer. An open heater has the advantage of acting as a purifier where the feed-water contains lime and similar impurities, and is also somewhat more compact as it may be made to act as a com-

bined purifier, receiving tank, oil separator, and feedwater heater.

Some engineers prefer, however, to separate these operations of apparatus and employ a closed heater, which can be cut out by means of valves when its services are not required. The amount of heating surface in this type of heater will depend somewhat upon the form of the tubes and velocity of water through them, but ordinarily they are rated at 1/3 sq. ft. of heating surface per boiler horsepower when used in connection with noncondensing, and ½ sq. ft. per horsepower when used with condensing engines. In the case of open heaters, the pan or tray surface commonly runs from 2 to 9 sq. ft. per 1000 lb. of water heated per hour, depending upon the amount of scale-forming ingredients. For medium conditions 6 sq. ft. may be taken. The size of the settling chamber commonly varies from 0.3 to 0.4 of the entire volume of the heater in the horizontal type, and from 0.4 to 0.6 the volume in the vertical type.

Condensers

IN the case of office buildings and similar plants a condenser is not commonly employed unless for summer use. It is evident that it would be a waste instead of an economy to condense the exhaust steam in a condenser, and use live steam for heating, unless the amount required for heating was a small proportion of the total exhaust produced.

There might be conditions where the power developed was large in comparison with the amount of space to be heated, and where the saving by running condensing would more than offset any loss by throwing away the exhaust steam. Conditions like this, however, are not likely to occur in office buildings unless it be in a very mild climate. Sometimes, where the heating season is short, condensers are installed for summer use, and for this reason it may be well to touch briefly upon this apparatus in the present article.

Of the 2 types, the surface and jet condenser, the former is heavier and more bulky for a given capacity, but may be used with any kind of water, which is not the case with the jet condenser, if the discharge is to be fed to the boilers. The condensed steam from a surface condenser may be used again in the boilers if 10 to 12 per cent of fresh water is added to prevent its corrosive effect. In cases of this kind the steam circuit is practically closed, except for the dilution with fresh water as mentioned above.

In the jet condenser the cooling water and the condensed steam are mixed, therefore, if the cooling water contains injurious elements, the boiler feed must be drawn from a separate supply.

Cooling Water Required

POUNDS of cooling water required in any particular case for a jet condenser may be determined approximately by the following rule:

From the total heat in a pound of steam at exhaust pressure, subtract the temperature of the discharge water and add 32; divide this result by the difference between temperatures of the incoming cooling water and the discharge water; the quotient will be the pounds of cooling water needed per pound of steam to be condensed.

In average practice it is customary to assume this value at 25 to 30 lb.

Cooling Surface

COOLING or tube surface in square feet for a surface may be found by the rule:

Multiply the difference between the temperature of the steam at condenser pressure and the average temperature of the cooling water by 180; multiply the weight of steam to be condensed per hour by the latent heat of steam at condenser pressure; divide the second result by the first and the quotient will be the square feet of condenser tube surface required.

For average conditions with the cooling water at a temperature of 60 deg. there should be from 2 to 3 sq. ft. of cooling surface per indicated horsepower of the engines.

Under ordinary working conditions the effect of attaching a condensing apparatus to a power plant is approximately the same as increasing the mean effective pressure of the engines by 12 lb., from which the actual increase in any given case can be easily approximated from indicator cards taken under present conditions, or by adding 12 lb. to the assumed mean effective pressure of the non-condensing engines of a new plant.

FACTS OF THE PITTSFIELD, MASS., EXPLOSION

THE second chapter of the story of the boiler explosion at Pittsfield, Mass., by which on Dec. 29 last 17 men were killed, proves to be more interesting than the first. A study of the official record of the testimony given at the inquest shows that the earlier reports of the accident, and of the circumstances which preceded it, was seriously inaccurate. With 35 witnesses testifying at great length this earlier inaccuracy was natural. Even the printed record of their testimony is not absolutely easy reading, but it gives a pretty clear idea of what happened before the explosion, and fixes the responsibility for the disaster on one man, who has paid the extreme price for his lack of judgment. The story should be of particular interest to operating engineers, for though very few licensed engineers are likely to repeat the course followed by the Pittsfield engineer, the various conditions connected with the explosion offer fruitful material for discussion as practical problems.

As disclosed by the official record, the situation was actually a good deal different from that described in the first reports, and it is necessary to state it in order to see just what kind of a case the dead engineer had to deal with. The boiler was examined by State Inspector Forbush last March, that being the first time the boiler had been inspected by the state authorities. He found on the boiler a 2½-in. safety valve of the ball and lever type. The valve outlet had been reduced to 2-in. diameter by a bushing and the discharge was through this bushing and a 2-in. pipe opening on the outside of the engine house. In the course of his testing of the boiler, Inspector Forbush unscrewed the steam gage and gave it a hydraulic test on a pump he had brought with him for the purpose, and the boiler gage gave correct readings by the inspector's test gage.

Before replacing the gage on the boiler the inspector blew through the gage siphon tube and found it clear. This seems to prove that the gage itself was correct. Inspector Forbush decided from his calculations that a pressure of 70 lb. was allowable for the boiler. In a letter to the Morewood Ice Co., owners of the engine, Forbush gave certain directions for cleaning up the en-

gine, removing ash and bricks from about the furnace, etc., and gave the following orders for changes in the boiler itself: These words are a quotation from the carbon copy of his letter.

"Provide a new water glass in place of one now on boiler which is cracked.

"Provide a ¼-in. pipe size connection in location specified by me at time of inspection.

"Remove bushing and 2-in. pipe in discharge of safety valve so that safety valve will have a full sized discharge."

He did not, as the first reports had it, order either a new safety valve or a new steam gage. There was nothing the matter with either of these attachments except the bushing in the valve discharge. The requirement of a ¼-in. pipe size connection was a little item of Massachusetts procedure intended partly for the protection of the inspector and partly to insure thorough inspection.

Massachusetts inspectors, in making an external inspection of a boiler under steam, are required to test the gage by attaching their own test gage to a connection with the siphon of the boiler gage. The specifying of the place for this attachment should serve to secure a witness that the inspection was actually made. The inspector's letter to the ice company said that on the completion of the required changes and cleaning up a certificate of inspection would be issued.

Now comes the engineer's part of the story. He held a fourth-class license, the terms of which permitted him "To have charge of and operate hoisting and portable engines and boilers" only. The managers of the ice plant turned over to the engineer the inspector's letter of instruction and told him to do whatever was necessary and to buy whatever new stuff he needed. The managers themselves were unfamiliar with boilers and apparently did not even read the inspector's letter. The whole thing was turned over to their engineer and he proceeded to use his discretion as follows.

The precise order of the changes is not certain, but the main facts are clear enough. The pipe and bushing were removed from the safety valve as ordered. Under date of Nov. 17 the state inspector was notified by the treasurer of the company that his orders had been complied with, and a certificate of inspection was thereupon issued. This certificate, which specified a maximum pressure of 70 lb. was tacked up on the wall of the engine room some days or weeks before the first fire was built under the boiler.

Then the engineer, Dunn, began to exercise his judgment independently, acting on the general authority given him to buy whatever was necessary. The safety valve then on the engine was 2½ in. diameter, but on Dec. 21, a week before the boiler was first started, Dunn ordered a 3½-in. pop safety valve set to blow off at 80 lb. The valve was tested before it left the dealer's shop and was found to release at 80 lb. Practical engineers may well consider the wisdom or unwisdom of putting onto a boiler allowed a maximum of 70 lb. pressure, a safety valve of an inch greater diameter, set for 10 lb. greater pressure. The new valve was put in place on the boiler not later than Dec. 27.

The valve and the steam gage were very close to each other. In removing the old valve and putting in the new one there was quite certainly a good deal of hammering, and the only possible conclusion is that this hammering dislodged scale which later made its way into the gage siphon, caused the gage to read incorrectly by interfering with the pressure, and so misled the engineer into creating the conditions which caused the explosion.

A fire was started under the boiler on Dec. 28 and the state of affairs from that time until the boiler exploded at 9:30 a. m. the next day may be briefly summarized without spoiling the essential point. When the steam gage showed a pressure of 30 or 40 lb. the new safety valve set at 80 lb. blew off and this was repeated several times. The gage pointer, instead of moving steadily as it should have done, went forward by jumps and then fell back.

Dunn then asked Ward to tighten up the safety valve a little. The gage gave no different readings after this treatment. Dunn therefore took off the steam gage and sent Ward out with it to have it tested. It tested correct and Ward brought it back with a message to Dunn that the trouble must be between the gage and the boiler. There was no testimony to show whether or not this message was delivered to the engineer.

On the morning of the accident, fire under the boiler was started up again. The steam gage worked much as it had worked the day before but the valve did not blow off, because Ward, acting under Dunn's directions, had screwed down the safety valve 4½ turns. After the explosion the valve released under test at about 225 lb.

When the steam gage indicated a pressure of 8 lb., Dunn turned the steam blower half on. The pressure was so great that cinders and fire were blown out of the top of the stack. Ward was informed of this and turned the blower jet around to a quarter. It would seem that any engineer should have realized that a half way opening of his steam blower could not possibly blow cinders out of the stack with a pressure of only 8 lb.

Dunn, however, continued to move his fire. The testimony shows that the whole engine house was a perfect oven for heat, and that the old grease on the boiler and engine was burning. There was plenty of water in the boiler. Shortly before the explosion the safety valve blew off with a tremendous roar several times, the pressure being then on the boiler certainly over 200 lb. There was no mystery about the explosion. The boiler carried 3 times its allowed pressure for some hours before giving way. The mystery is, how the engineer managed to dodge the plain meaning of the emphatic signs before him.

THE INSTITUTE OF OPERATING ENGINEERS

ON February 6, the second meeting of the Chicago branch of the Institue of Operating Engineers was held in the rooms of the Western Society of Engineers, a good number being in attendance. The first work that came up in the meeting was reports on the by-laws and the report as presented by the committee which practically embodied the provisions of the proposed National Constitution was adopted. The report of the nominating committee was then presented and the following officers were elected: President, Charles W. Nayler; Secretary and Treasurer, O. Monnett; Lecturer on Power Plant Operation, W. L. Jackson, and Lecturer on Educational Topics, I. J. Bent. Members of the Council for three years, Jos. P. Fleming, John F. McGrath, Prof. A. W. Moseley; for two years, John R. Moore, Arthur L. Rice, Prof. G. F. Gebhardt; for one year, Walter Cadwell, W. G. Lightey, J. C. Miller.

After the transaction of business the meeting was addressed by Mr. W. L. Jackson, who had just been

elected lecturer on Power Plant Operation, and who is engineer of the First National Bank Building, on the topic of Business Management in the Power Plant. He showed lantern slides of a large number of forms which he uses in keeping records and also blanks filled out showing the results obtained in operation. The last form shown was a summary for the year showing the cost of labor, fuel, supplies, and so forth, and also the receipts and credits for power supplied for various purposes. The showing made was certainly a remarkable one and extremely favorable for the case of the isolated plant. The discussion was continued for a considerable time, Mr. Jackson answering many questions as to how he figured his costs, and the members showing great interest in his methods of keeping records and in the results that he obtained.

Following Mr. Jackson, C. M. Ripley of New York spoke of the need for reliable facts in regard to the performance of isolated plants and showed how the

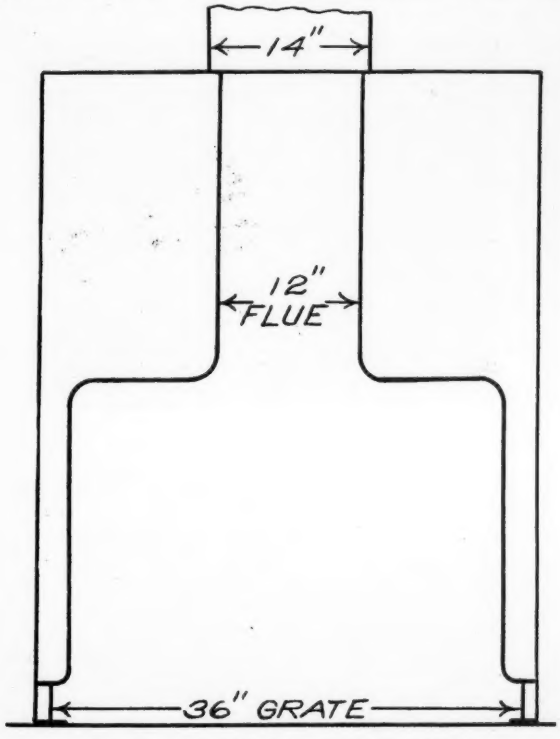


FIG. 1. SECTION OF EXPLODED BOILER

arguments frequently presented by central station canvassers in regard to the comparative cost of central station power and isolated plant power were not based on correct assumptions as to the cost of operating the isolated plant and the returns from such operation. The meeting adjourned subject to the call of the council.

The address of the Secretary of the Chicago branch is Railway Exchange Building, Chicago, Ill.

IN THE Massachusetts Supreme Court for the county of Suffolk, an injunction has been granted to the Jerguson Mfg. Co., prohibiting other companies from acting as United States agents for Max Richter & Co., of Dresden in the sale of the gage glasses made by the latter company. This leaves the Jerguson Mfg. Co., as the sole American agents for the Richter & Co., gage glasses.

BOILER EXPLOSION AT NEW LEXINGTON, OHIO

ONE Sunday afternoon recently at about 5 o'clock, the boiler in the pumping station of the T. & O. C. Railroad exploded, killing the temporary fireman, James Kelley, Albert Funk, whom he had asked to assist him, and severely injuring Dea Funk, a child who was standing near. The regular fireman, George Funk, was away and Kelley was taking his place. The boiler began to act badly and

FIG. 2. SITE OF DEMOLISHED PUMP HOUSE

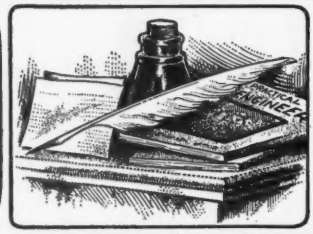
while he and Albert Funk were trying to locate the trouble it let go, with fatal result. The boiler was blown 100 yards and the wreck of the pumping station was complete.

Witnesses of the explosion say that the boiler went about 100 ft. in the air as well as 350 ft. to one side. It was an upright shell 48 in. in diameter and 8 ft. high, with one flue 12 in. in diameter, and

FIG. 3. THE BOILER AS IT LANDED

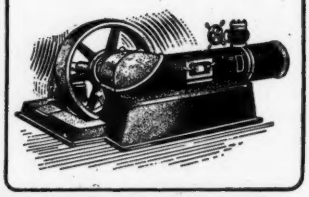
14-in. smoke stack. It was installed in the place where it was used 12 yr. ago, and was second-hand at that time.

A short time before the explosion the boiler commenced to leak at the bottom of the inside shell and the engineer reported it to the railroad company, which sent a boiler maker who repaired it as best he could, using a cement. The accident is a good illustration of the damage that even a small boiler can do when not kept in proper condition and not handled by men thoroughly competent to do the work.



Letters from Engineers

Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



SINGULAR GAS ENGINE CRANK SHAFT FAILURE

ON coming to work one morning a few weeks ago, the night engineer reported that engine known as No. 2 in our plant of 4 gas engines, a 3-cylinder, 14 by 18-in., 175-hp. engine had laid down suddenly during the night, supposing that one of the igniters had become grounded, which quite often is the case when running with very light load. After examining the igniters and seeing that they were all right, the assistant engineer attempted to start the engine, and much to his surprise it commenced to turn backwards as soon as the air starting valve was opened. The air was at once shut off and the chief engineer's attention was called to the strange action of the engine.

The engine was again put into starting position, and the engineer was about to give it another trial when he noticed that the keyway in the crank shaft at the right end of the engine was not in the usual position for starting, but was nearly on the bottom where it should have been half way up on the back side. Looking back to the other end of the engine on which the flywheel with the jack notches is placed, it was found that this keyway was in the proper position, so in comparing the 2 keyways it was found that one was almost a quarter of a turn ahead of the other when they should be on the same line.

Then an examination was made on the inside of the crank case, where the trouble was soon discovered. The

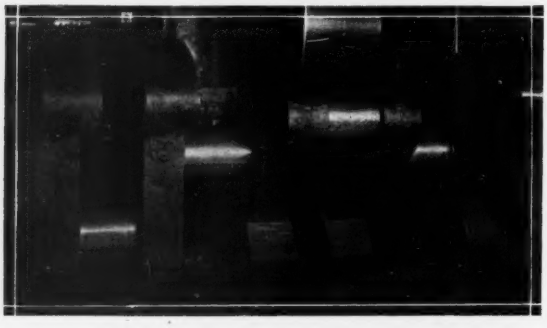


FIG. 1. ENGINE SHAFT AFTER ACCIDENT

3-throw shaft is made up in 3 sections, the 2 center crank disks and wrist pin being 1 piece and the 2 end cranks and ends of shaft making the other 2 pieces. It was found that where the right crank section was pressed and keyed into the center crank disk that it had sheared the key and the right crank had slipped back until it was within 15 deg. of being even with the center crank, when it should have been 120 deg. ahead of it. The right cylinder is the one used in starting the engine with compressed air, and as the exhaust valve cam shaft was driven from the other end of the engine, the right crank had slipped back far enough so that it had made the action of the exhaust valve in that cylinder nearly opposite to what it should have been, and when the air was turned on the engine turned in the opposite direction, but of course the other cylinders did nothing.

After the shaft had been taken out and a new one replaced, the old shaft was taken apart at the point

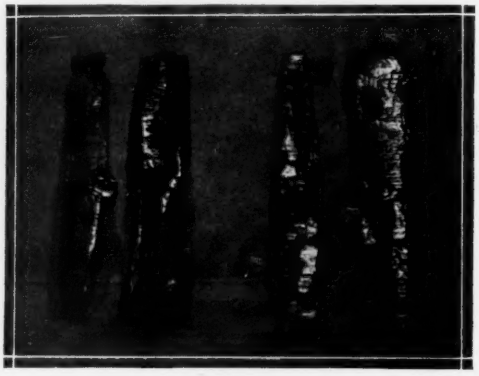


FIG. 2. PORTIONS OF THE KEY

of the sheared key. This was done by using blocks of iron and a long tapered iron wedge. The shaft was supposed to be pressed together by high hydraulic pressure, but upon using the wedge it moved quite hard for the first inch and then kept getting easier until the last inch was pushed off with a screw jack. The key which was 2 in. square by 6 in. long, as will be seen by the illustration, was split in 4 quarters. The surface of the end of the shaft was worn smooth indicating that the shaft had been working some time before the key gave away.

L. M. Johnson.

KNOCK IN PUMP; FLOW FROM TANK; CARE OF IDLE BOILER

H. S. ASKS for suggestions regarding the knock in his Blake pump which works against 350 lb. pressure. From the size of his pump and the pressure against which it pumps, he must have some pretty good boilers, as the way I have figured it out he will have to have 186.9 lb. steam pressure to balance the discharge pressure, then taking into account the friction and a satisfactory speed it would require not less than 225 lb. steam pressure, therefore I believe there is some mistake.

There are several things that could cause a bad knock: the spool on the rod, if fastened by means of a set screw, might have slipped, or some of the valve stems might have a shoulder worn on them, and one or more of the valves hang up; either one of the suc-

tion or delivery valves could cause this, but the more likely cause would be an excessive amount of lost motion in the valve gear; if the valve stem links or pins are badly worn in a duplex pump it will knock hard in the water end. The remedy is to put in new links and pins or repair them, as I have found done by drilling the holes larger in the links and then babbitt them on the pin; or if the pump cannot be spared long enough for this take off the steam chest cover and slip on 1 or 2 washers beside the nut in the valve and so decrease the lost motion in the valve. This remedy has often helped me in getting work out of old pumps that were badly worn, and which I could not spare at the time for more thorough overhauling.

Replying to H. S.'s question and diagram, I believe the pipe directly from the bottom of the tank will carry the most water as the longer the pipe the less water will flow at a given pressure and these 2 pipes have the same pressure after both are started, besides the 2 elbows increase the friction to a considerable extent.

I have been very much interested in the articles about the care of idle boilers and will tell you what I do with them, whether right or wrong. When I have a boiler to cut out for a month or for several months I take plenty of time and try to do a thorough job. I let the fire burn out and then cut the boiler off the line, close the damper and clean off the grates and ash pits, scrape and blow the tubes, then let the boiler stand until it is cold and the setting as cool as it will get. Then I have the back connection opened and all the soot and ash back of the bridge wall cleaned out and then with a short broom sweep off the shell and heads and clean out the smoke box. Then open the blow-off valve and let all the water out, take off the manhole plates and give the boiler a good washing from above and below the tubes.

When the boiler is dry I go in and give it a good inspection and put things, inside and out, in as good shape as I can, then I fill the boiler to 3 gages, and cover the grates with coal, so if it is needed all that will be required is a little fire from one of the others at the front of the grates. In this way, though the boiler may be idle for some time, it is always ready should it be needed.

It is my belief that with good water no harm comes from filling the boiler in this way, but on the contrary is beneficial; the water cannot deposit any scale, being cold, and it tends to loosen what scale there is in the boiler, which to a certain extent will fall off when the fire is started and may be blown out the blowoff. I always blow off a gage of water before steam is fully up and also about twice a day after it is cut in and I have never been given any trouble nor experienced any bad effects from this method.

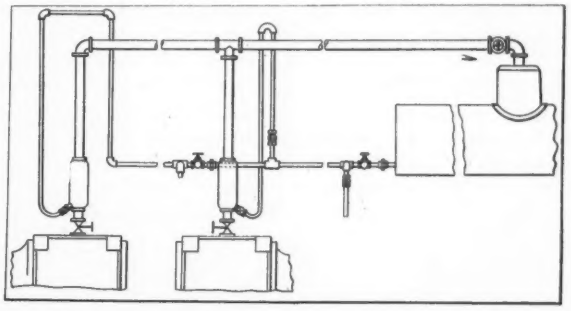
A. O. White.

USE OF STEAM LOOP

IN questions and answers of a recent issue I notice that a brother engineer asked the best way to connect a steam trap to 2 engines to get the water into his heater. While the answer is all right why does he not put in a steam loop and put his water directly into his boilers and get the benefit of heating the water to about 100 deg. F. and at no cost except 6 1-in. globe valves, 1 check valve and a few fittings and pipe enough to run to his boiler? He will never have any trouble to keep it up as there is no more wear to it than a steam pipe; it is positive in action and keeps working all the time, puts the water into the boiler at practically the temperature of the steam.

I never use a trap on a steam separator as I find the loop works better and gives me less trouble than anything I can use. It is singular so few engineers seem to know about it when it has been written about so often in the mechanical journals.

I will state that if the party writing wishes to put in a loop, he should put one for each engine separator, have the riser at least 2 ft. for each lb. difference in pressure at his separator and his boiler, then add a few ft. to help along the slugs that may come over. Only one line is necessary to carry to the boiler. I have run as many as 4 loops in one line to my boilers



LOOP ARRANGEMENT FOR DRAINING 2 SEPARATORS

and they worked as good as any one could wish. I use a tee and valve to blow out just at the main line to my boiler with a valve between the tee and main line.

When I want to start the loop working I close valve on line to boiler, open valve below tee to the atmosphere, let it run till live steam shows, shut off open-ended valve and open the one to boilers and it will work till the steam is cut off of separator without further notice or bother. J. H. Lamar.

WASTING WASTE

PERHAPS one of the most common wasteful habits is that of the waste of waste. In a great many plants this material is used for cleaning machinery of all kinds and whenever there is a generous supply on hand, there is generally some man on the job who is very "wasteful." When waste is used for these purposes, it should be used first to polish the bright work, switchboards, window panes, etc., then for wiping off the cleaner machines about the plant, such as engines, generators, motors, etc. After this it may be used again for cleaning off boiler fronts, wiping up grease or oil that may have been spilled on the floor and various other dirty work about the plant. Instead of using soiled waste for dirty work a good many men use clean waste and often throw it away after one using. While this may seem like a small thing yet in the course of a year it often amounts to considerable.

In a 275-hp. plant of which the writer had charge, the average amount of waste used was about 50 lb. per month. This waste cost 9c per lb. or $4.50 a month; as will be seen this amounts to $54.00 per year. There being a laundry in the building, a good many clean rags were available. These, together with tungsten lamp wrappings, were used instead of the waste, thus making a saving of a little more than $50.00 per year.

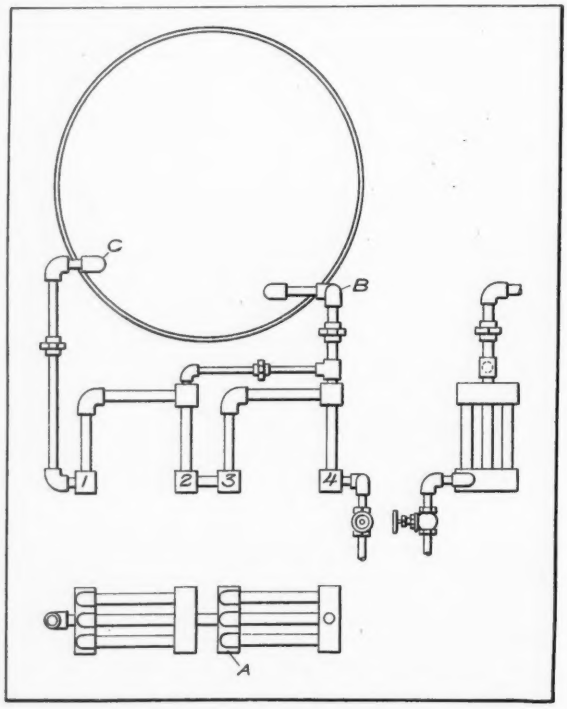
The waste is not only an expense, but is also bad about raveling out and dropping on the floor when being used. It also often gets into the armatures and brush holders of electrical machinery and has been the cause of many a hot box by getting into the oil and stopping up the feed.

In a good many buildings, especially office buildings, there is a large number of old ink blotters thrown into the waste baskets. These old blotters are an excellent absorbent of oil and will come in handy in the engine room. R. L. Rayburn.

LEAKING WATER FRONTS

WE have 5 6 by 18 ft. high pressure boilers and 4 of these are equipped with water fronts as shown in the sketch. All 5 are set in one battery and when the load is on we need all the steam they will make.

We were running along under full load one night when the fireman reported one of the water fronts



WATER FRONT ARRANGEMENT

leaking badly. I went into the boiler room and as I opened the furnace door of No. 5 the corner at A blew out and started to blow the fire over the bridge wall. I sent for the chief and meanwhile cut out the boiler, blocked open the safety valve and opened the blowoff, got 2 1¼ in. couplings and plugs and made them up.

When the chief arrived we tried the water column pipe and saw that no water came from it; then I played the fire hose on the pipe and the chief broke the ell off at C and put on the coupling and plug, then did the same thing at B. We then filled the boiler, fired it up and in an hour had it back on the line.

The chief turned to me and said: "You know it is not according to the best practice to cut out a boiler, cool her off and start her up again in an hour." I told him I knew it and also I knew that he told me to keep the wheel turning, no matter how I did it. I was just saying that if the same thing occurred again I should follow the same course, when a loud report brought us back to the fire room and we discovered the same thing had happened to No. 3. We had to go through the same performance again and before morning we had the same experience with Nos. 4 and 2. Shortly after this we got new boilers, 2, 3, 4 and 5, and used the same water fronts that were on the old boilers, regardless of the burning they must have got while running dry, but they have caused no trouble since.

A. W. Griswold.

TAMING A BEARING

HERE is a little experience I have had in babbitting that may prove of value to some of my brother engineers. Where I am employed we have a 3-in. countershaft about 15 ft. long, it has 3 common pillow block boxes and runs at about 390 r. p. m. The drive is short so that we always have to have our belts tight; consequently this shaft always ran warm and required a good deal of attention. And not only that, the floor around those boxings was always dirty and oily.

Last winter we rebabbitted those boxes; we jacked the shaft up, took the boxes out and melted the old bab-

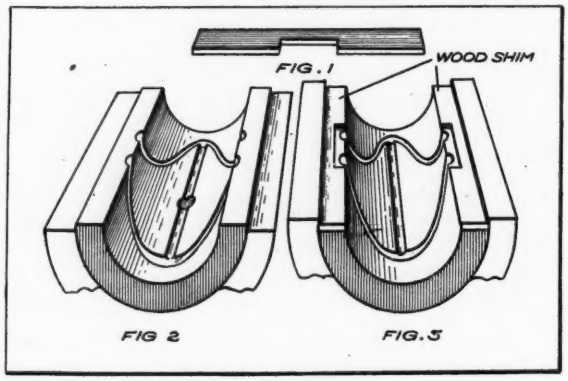


FIG. 1. SHIM USED BETWEEN BEARINGS
FIG. 2. UPPER HALF OF BEARING, BABBITTED AND GROOVED
FIG. 3. LOWER HALF OF BEARING WITH SHIMS IN PLACE

bitt out, then put them back and lined the shaft through the center of them. I made some wooden shims out of a yard stick and fitted them between the halves of each box so that they would fit snug to the shaft, cutting a piece out of each center, as shown in Fig. 1, to allow the babbitt to flow in the lower half of the box as we poured from the top half through the ½-in. hole into which the oil cup screwed.

The boxes being still warm, I took some cardboard and common clay and "mudded" up the ends, then poured the metal; after they cooled I took them out, scraped them, then cut oil grooves, as shown in Fig. 2 the top half and Fig. 3 the lower half, using a chisel ¼ in wide and not cutting very deep.

Instead of using oil again, I put a 2 by 3-in. compression grease cup on each bearing. I have filled them just 4 times in 9 months, and always have a clean floor around that shaft. The wood shims give enough, so that drawing down the nuts makes the shaft fit the boxes snug, forcing the grease to follow the shaft around through the oil ways, and allowing very little leakage endwise along the shaft. The shaft still runs warm to be sure, but just warm enough to keep No. 2 grease in a fine liquid state. This shaft runs on an average of 15 hr. out of every 24. W. E. H.

PECULIAR GAGE TROUBLE

READING the account of the Pittsfield, Mass., boiler explosion, with its horrible results, which in my mind could have been averted with just a little forethought, reminds me of a bit of my own experience with a steam gage along the same lines as related in the account referred to.

In this plant, there are 12 boilers to be looked after, each is 72 in. in diameter by 18 ft. in length. Each is fitted with a gage and arranged to be cut out or in as the occasion may demand. The fires are managed from 1 gage, regardless of the number of boilers in service, and there are times that each gage in the plant has to be depended upon to give notice of the pressure that is on the boiler. Consequently it is necessary that the gages be kept in a correct and good working condition.

Only recently the head stoker came and reported that one of the gages was working badly and found upon investigating the matter that the gage was 25 lb. short, i. e., it showed 80 lb., while the other gages were at 105 lb. The first assistant was instructed to close the valve that admitted pressure to the gage and remove and bring the gage to the engine room, and while attaching it to the gravity weight testing machine I told him to open the valve to learn if it would pass any steam and upon returning reported that steam came out all right. The gage proved to be exactly right from zero to 120 lb., and was replaced and the pressure turned on with the result that it worked the same as before it was taken down.

The boiler was cut out of service and cooled down; the gage connections were taken down and taken all apart and thoroughly cleaned; there was found in and near the valve a substance representing rubber, rust and sand, mixed together and of a pinkish color that apparently stopped up the passage at a certain pressure. Compare these observations to the working of the gage on the Pittsfield boiler previous to the explosion.

After the fittings were replaced, steam was raised on the boiler and the gage worked all right, and has since showed no evidence of anything being wrong.

Engineer.

PUMP REGULATOR

AS a suggestion in reply to Mr. Peacor's query in the December issue of Practical Engineer regarding the trouble he has experienced with the float arrangement shown, I would recommend that he replace the butterfly valve shown in his sketch with a globe valve.

He should then make a small wooden pulley, say 8-in. diameter and having flanged rims ½ in. deep to keep the rope from slipping off.

This pulley can be attached to the wheel of the globe valve by means of hook bolts made of ¼-in. iron. Attach the pulley to the valve wheel and pass the float rope around the pulley once or twice as may be necessary to keep the rope from slipping and in such direction that the descent of the weight will open the valve, i. e., from left to right.

The trouble with his present arrangement, as I see it, is that the butterfly valve is not sensitive enough as it gives too much opening or closing on slight variation of the water level. With the scheme outlined above he can adjust the globe valve to about normal running position, then place the float rope in position and he will have a very sensitive regulator.

I assume that he has his float boxed in, though it is not so shown. If it is not, this should be done by making a wooden box open at the ends and of such size that the float will work through it without sticking but will be prevented from floating around on the surface of the water.

On several occasions I have found it necessary to replace the arrangement Mr. Peacor shows by the one described and always with satisfactory results.

O. B. Critchlow.

AUTOMATIC GOVERNORS

SOME of our engineers at times become puzzled with their automatic engines. Not long since we ran across an automatic which was direct connected to a small generator, and upon letting the load off the voltage would gradually go from 125 to 140 or more if we would leave the throttle. This had given the engineer trouble for some time in this way.

We soon had it under control. We first placed the engine on front center and removed the front cylinder indicator plug at E Fig. 2 and a little steam came out so we knew that the valve must be too far towards the crank end. So we placed it on the back center and having the plug removed a great volume of steam rushed

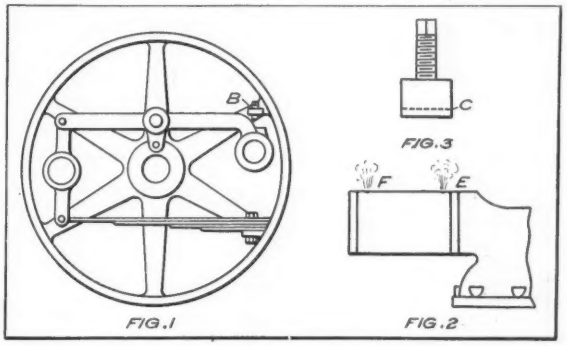


FIG. 1. FLAT SPRING GOVERNOR
FIG. 2. CYLINDER OF AUTOMATIC ENGINE
FIG. 3. STOP LUG SCREW FOR GOVERNOR

out at the point F. We knew at once that our valve must be moved away from the shaft or crank as the valve took steam on the outside end or edge, so we moved this back until our valve was practically at mid-position, and then upon starting our engine we found that we had it under better control, but still it would raise the voltage a little. We could see that the valve was not getting full throw, due to wear, or a slight leak beneath the ends to the port, so in order to bring this right, we looked to our governor. It was clear that the governor arm was going out against the stop lug B, Fig. 1, so we found that we could not screw this back any farther, consequently the engine was not under control yet. By cutting off the end of the stop lug screw up to the point C, as shown in Fig. 3, the engine was put under perfect control. We, however, first tested the machine with the lug entirely removed and found that the engine was under control.

There is considerable in the adjustment of the automatic engine valve gear that does not seem to be understood. We find few engine room men who fully understand the working of the flat spring, or the difference between the flat spring and the coil spring. All engines using the coil spring are quick or jerky in some points of the governor movement while the flat leaf spring is slower in its action than the coil spring. To

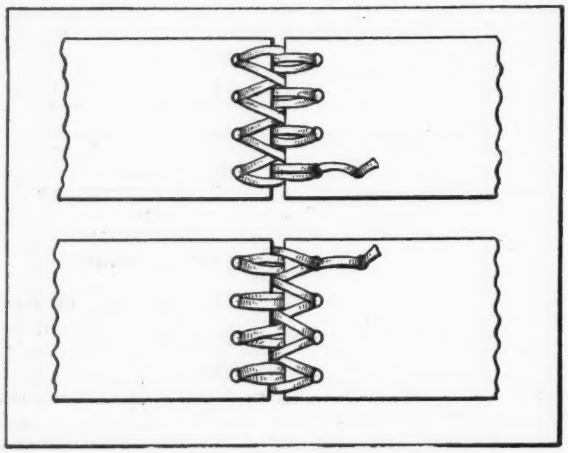
make this more clear, if we were to take our flat spring and place rollers between the leaves we would have an action more nearly that of a coil spring from our flat spring. It is the friction of the leaves of the flat spring that makes its action more stable or steady. It is quite necessary to fully understand these points to be able to change and make delicate adjustments of these governors. For instance, should we have a flat spring that was working too slow in action this can be remedied somewhat by placing some thin sheets of polished iron between the leaves, or slowed down when too quick by putting in some sheets of heavy paper which makes friction between the layers. So the flat spring can be made to work somewhat like the coil spring by some slight additions and changes. C. R. McGahey.

PECULIAR INDICATOR DIAGRAM

IN a recent issue appears a card with a jog in the expansion line and the question is asked what caused the jog. The writer will say that it was caused by the dash pot rebounding causing a reopening of the valve. Would like to ask W. E. C. if this is the correct answer. H. T. Fryant.

SPLICING BELTS

IN an article in the January issue on "Belts" there are several methods given of splicing them. One of these methods on page 6 is illustrated as the "best method of lacing belting." While my experience has been limited as compared to many who use this



A PRACTICAL HINGE BELT LACING

method, I take the liberty of offering another method which I consider superior to the one described.

It has the advantage that it may be begun or ended anywhere and does not make noise when it passes over a small pulley at high speed. Like the other hinge lace it wears longer because bending the belt does not increase the strain on the lacing. I prefer it to the method shown on page 7 because it is stronger.

A master mechanic who had about 2000 belts to look after showed me this method and said it was a common hinge lace. Since that time I have not found it in use in other places where I worked.

Theory says that the crossed laces should not run next to the pulley and that the strands on the pulley side should be parallel to the length of the belt. I would like to ask why? Practice has shown me that this method which I submit will outwear any of the others. Then why is it not the best?

I once saw an electrician lace an emery wheel belt several times in a single day according to several theories. I suggested my method but he refused to try it because he did not think it was "good manners" to run strands out of parallel to the belt next to the pulley. He thought the school method was the best, where one strand is on top of another on the pulley side, this double thickness of lace making a shock like a battering-ram when it goes over the small pulley.

When I had a cause to use the emery wheel I laced the belt my own way and it lasted. The electrician finally said outright that he did not think it was a good way of lacing a belt. It lasted 3 months, however, against 15 minutes for his method.

E. F. Jackson.

CARD COMMENT

JUST a few comments relative to "Such Cards," which appears in the February issue, page 167. As no data such as scale of diagrams, boiler pressure, etc., accompanies the cards, other than that the type of engines from which the several cards were obtained, is mentioned, a full and fair criticism cannot very well be made. There are other things to be considered as well as the general outline and appearance of an indicator diagram, if a fair and square criticism is to be made. Simply judging from the cards as given, however, and knowing from what kind of engine each one was taken, I offer the following:

Card 1. Ordinary diagrams; usual high back pressure for high pressure cylinder. Engine slightly overloaded for the existing boiler pressure, as shown by the comparatively late cut-off. Speaking in general, cards pretty fair, although a little out of balance as regards power at crank and head ends.

Card 2. Engine carrying an enormous overload for existing boiler pressure, as shown by steam following the piston for nearly full stroke. Power not evenly distributed between head and crank ends of cylinder.

Card 3. Engine overloaded; valve gear deranged, apparently leaking valves (steam valves) or piston, or perhaps both. Possibly indicator cock not fully open at crank end, when that diagram was taken, as shown by the full pressure not being realized at that end, on the diagram. It may be possible that there is some obstruction in the crank end indicator pipe, or perhaps it is longer than that of the head end. The valve may not open quickly enough owing to an incorrect adjustment of the wristplate, reach rod or eccentric rod.

Card 4. Also an overloaded engine; and apparently leaking steam valves as shown by the incorrect form of the expansion line. Compression release and lead are about right judging from the diagrams. Steam valves close too slowly, perhaps due to weak dashpot action.

Card 5. Deranged valve gear, or incorrect adjustments. Restricted exhaust, head end diagram. Leaky or slow closing steam valves as referred to for the other cards. Perhaps here, also the indicator cock has not been full open when the crank end diagram was taken, as full pressure is not realized at all. The crank end terminal pressure does not correspond or agree with the late cutoff. Possibly an obstruction in the indicator piping as referred to for card 3. Very low back pressure, assuming the card is from the high-pressure cylinder, possibly it is the low-pressure cylinder, noncondensing.

Card 6. Looks as though these diagrams were taken under similar conditions as was card 5, excepting as to the character of the expansion lines in the crank end.

In the crank end, 6, the steam is expanded below atmospheric pressure before the exhaust valve opens, as shown by the loop. As soon as the exhaust valve opens the normal back pressure is reached. As in card 5, the head end is doing more work than the crank end, owing probably to a poor adjustment of gear.

Card 7. These diagrams are not very bad, except for the lead appearing to be not sufficient, as shown by the rounding upper corners of both diagrams. The head end is doing a little more work than the crank end, as shown by the larger area of that diagram. More than one revolution has been traced, as shown, by the double expansion lines. Release, compression and back pressure appear to be all right.

Card 8. These look like diagrams from the low pressure cylinder, non-condensing and friction load only. I have cards exactly like that, taken under the condition I refer to. Most all negative work in the low-pressure cylinder, as shown by the excessively large loops.

Card 9. Nothing particularly remarkable about these diagrams when the type of engine is considered. Fair diagrams, all considered. Back pressure high, but may be so for a purpose.

Card 10. Overloaded engine. Lead late, release late, unequal power. Eccentric requires more angular advance, and governor rods readjusted. Reduce load, or increase pressure, if conditions all round will permit.

Card 11. Nearly the same as 10, but not quite so bad. Same remedies may be applied.

All these cards make an interesting study, and afford an excellent opportunity for discussion, until W. D. tells all that he knows about them.

Charles J. Mason.

CUTTING GAGE GLASS; POLISHING SHAFTING

IT sometimes happens that the engineer finds it necessary to cut a water glass; where he can not lay hands on a file or tube cutter, he can do it equally as well and quickly by moistening the head of a match till the phosphorus is pasty, smear a ring of it around the inside of the glass, light another match and hold

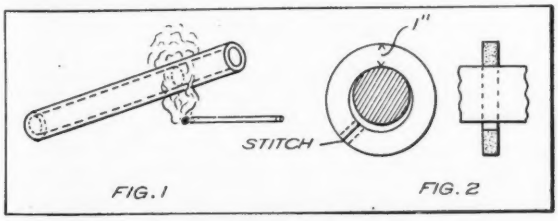


FIG. 1. METHOD OF BREAKING GAGE GLASS
FIG. 2. WASHER USED TO POLISH SHAFTING

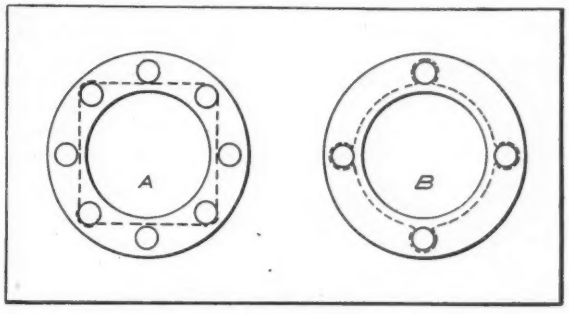
it on the outside heating the glass at the place where you have smeared the sulphur inside. When the sulphur inside has heated and begins to smoke, hit the end of the glass. It will break like a whittled twig.

It is not a pleasant task to polish overhead shafting by means of 2 hinged sticks with a piece of emery cloth nailed to each stick. The job can be dispensed with for good by making a leather washer about ¼ or 3/16 in. larger than the shaft, and cutting it, slip it over the shaft. Its weight on the shaft will cause it to rotate and travel the rod until it encounters an obstruction in the way of a box or pulley; it will then be sent in the opposite direction till it encounters a like obstruction at the other end of its travel. Its continued friction on the metal will keep the shaft bright and shining. These travelers need no attention. They get enough oil from boxings and pulleys to keep them soft. A little expense of making these washers and putting them on will keep thousands of feet of shafting clean and bright with no attention or further expense, for many years. F. W. Bentley, Jr.

SECURE PACKING FOR FLANGE JOINTS

TO those engineers who are troubled with packings blowing out whether on high or low pressures, whether it be on flange unions, steam chest covers cylinder heads or whatever it may be, to those this article is intended. Figure A is a flange union which is generally used on high pressures although some of them have only 6 bolt holes instead of 8, as in this drawing, while B is for low pressures and is as a rule not so troublesome as the high pressure union.

I scrape off all old packings when making a new joint and see that surfaces are clean and free from any lumps caused by old packing remaining on the flange. I procure some No. 14 copper electric wire, any copper wire is all right but when you are connected with an electric light station old electric light wire is good enough, bend the wire into the shape shown in drawing, A for high pressures, the same method is also used

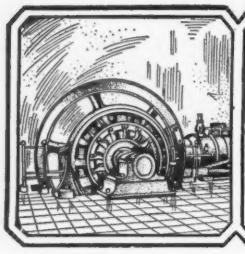


WIRE FORMS USED TO PREVENT PACKING FROM BLOWING OUT

for low pressure as shown at B. Put the packing in place by putting the top bolt through hole in packing, also see that copper wire which you have shaped is on this bolt. While this holds packing and wire in place other bolts can be inserted in their respective holes and screwed up tight. By tightening up on the bolts the copper wire imbeds itself into the rubber packing. I have used this method with success a number of times and know that it does away with a lot of trouble caused by rubber packings blowing out. E. W. M.

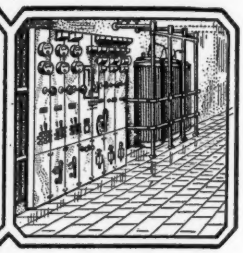
LIFE is the best job ever I struck,
A four-leafed clover job, brimmin' with luck;
It's a hustlin' job and the hours is long;
But you git your wages in laughter and song;
And every mornin' the work grows lighter,
The pay gits bigger, the fun grows brighter;
And the more you do, why the more you get
And all that you earn is your own, you bet;
There's sun in the day and stars in the night,
And work spruces up your appetite,
And you got no kick whilst your heart holds true,
For joy will come and keep house fer you.

—St. Paul Dispatch.



Electrical Machinery

For Generating, Transmitting and Using Current



OPERATION HINTS

CAUTIONS ABOUT ELECTRICAL MACHINERY

By John C. Kahl

WHEN THE LOCATION OF a machine is determined, it should be chosen with the view that the machine shall not be exposed to moisture nor to dirt or dust from the handling of coal or other causes. It should be placed in as cool and well ventilated a place as possible, because a well ventilated machine will carry heavier loads and deteriorate less than one unfavorably located.

All machines should be set on substantial foundations in order to prevent vibration when running. Solid masonry is best for a foundation, but a framework of timber may be used for machines that are well balanced.

It is well to keep the iron of a low voltage machine insulated from the ground, and with this in view the bolts securing the machine to its foundation should not come in contact with any other metal or electric

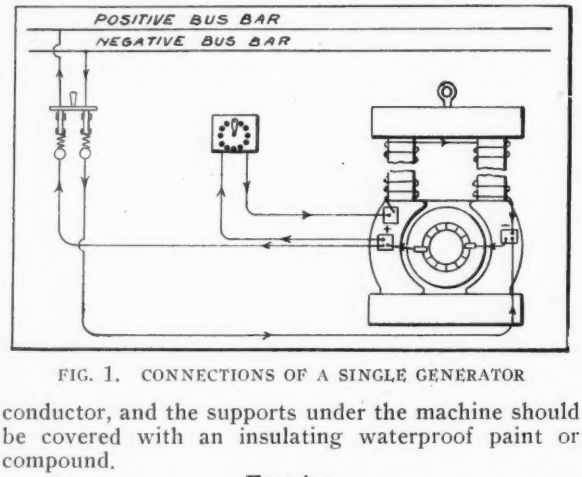


FIG. 1. CONNECTIONS OF A SINGLE GENERATOR

conductor, and the supports under the machine should be covered with an insulating waterproof paint or compound.

Erection

WHEN setting a belt-driven machine upon its foundation, it should be carefully leveled and the pulley accurately lined up with the driving pulley. In erecting large machines, first get the lower half of the field magnet yoke into position, then place the armature shaft into its bearings and then put on the upper half of the field magnet yoke. In bolting together the upper and lower halves of the field magnet yoke, all dirt should be brushed off the surfaces in order to bring them into perfect contact; otherwise there may be an unnecessary weakening of the field magnetism.

Weight of an armature should never be supported at all on the commutator, nor should the commutator be allowed to rest upon any blocking. When handling the armature, it should always be supported by a rope sling about the shaft and the shaft be covered with bagging, so as not to mar or scratch the journals, as any roughness would cause cutting in bearings and thus cause them to heat.

Connections and Starting Up

IN Fig. 1 is shown a single generator connected up with the rear of the switchboard.

To operate it see that the oil gages show the proper amount of oil in the bearings and that the tension of the brushes is correct for good contact. Start slowly and see that the oil rings are revolving freely, then get the machine up to speed, raise the voltage to the proper amount by cutting resistance out of the field circuit at the rheostat.

After this is done, the main switch Fig. 1, may be closed. Give the brushes as much forward lead as possible when generating the full rated voltage at no load and secure the brush rocker at this point, as this will be the best position for operation with fixed brushes and a simple shunt wound machine.

To shut down the machine cut in resistance at the rheostat until the ammeter shows that the machine ceases to generate any current, when the switch may be opened and the remainder of the resistance of the rheostat cut in.

If a circuit breaker is provided, as is generally done in the case of railway or power machines, the circuit breaker may be opened, then the main switch, afterward cutting in the resistance of the field rheostat; then stop the machine and clean it, ready for another run.

Parallel Operation

IN the case of 2 simple shunt wound generators operated in parallel, the connections of the second machine will be an exact duplicate of those shown in Fig. 1, except that both will be connected to the one set of bus bars.

When bringing one machine into service while the other is in operation, it will be necessary first to bring it up to speed, then adjust its voltage until it is equal to that of the machine already in operation, when the circuit breaker if there is one may be closed; then the main switch may be closed, and the load equally divided between the 2 machines by adjusting their rheostats. This is done by cutting in some of the resistance of the rheostat on the loaded machine and cutting out some of the resistance of the rheostat on the

machine upon which it is desired to put a portion of the load. The rheostat manipulation may be continued gradually until the load is equally divided between the 2 machines. When it is desired to withdraw either of the machines, the load should all be shifted to one machine by adjustment of the rheostats; then the circuit breaker or the main switch on the machine from which the load has been taken may be opened, the resistance of the rheostat all cut in, and the machine stopped and cleaned.

To operate compound wound generators in parallel it is necessary, in order to have each one work in pro-

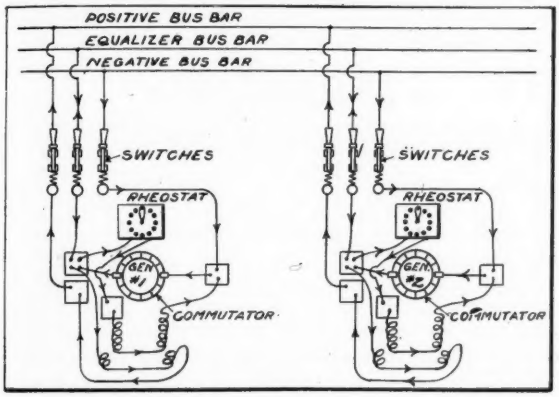


FIG. 2. GENERATOR CONNECTIONS FOR PARALLEL OPERATION

portion to its capacity, to connect them in 3 places, at the main terminals of each machine, and at the junction of the series winding and the brushes to which it connects; the connection from the junction of the series winding and brush is called the equalizer wire and extends to an equalizer switch, represented in Fig. 2 at the center of each set, which in turn connects with the equalizer bus bar.

If the generators are of the same size and make, the only point requiring special attention is that the wires which run from the different machines to the equalizer bus, shall all be of the same resistance, as the main lead wires.

If the generators differ in design or size the matter becomes more complicated. In this case the difference of potential or drop in voltage between the junction of the series winding with one of the brush cables and the bus bar to which the other end of the same series winding is connected should be exactly the same for every generator when each is carrying its proper share of the load. To make this drop the same for each generator it will become necessary to place resistance in circuit with the series field coils of the one showing the smaller drop. The equalizer wires must show as little drop as possible and never more than the generator leads.

Large machines require several hours for their field magnet coils to attain a constant temperature and as the coils heat up it becomes necessary to cut out resistance in the shunt field circuit at the rheostat or field regulator.

Three-Wire Generators

TO operate 3-wire generators in multiple or parallel, 2 equalizer wires are necessary; one extends from the positive and one from the negative commutator brushes. The balancing coils are usually connected to the collector rings through switches, the neutral wire being taken to the switchboard and finally connected to the neutral bus bar. It is unnecessary to connect the alternating leads from the armatures in parallel, nor is it necessary to consider the periodicity of the alternating currents generated by the different machines.

Three-wire machines may be operated together, irrespective of the number of poles and speed, as easily and simply as 2-wire generators, and 2 and 3-wire machines may be run in parallel with each other.

In a large station with many units it is therefore practical to operate only one 3-wire generator, provided that it has sufficient capacity to carry the difference between the loads on the 2 sides of the system, and all other machines may be of the ordinary single voltage or 2-wire type. It is, however, advisable to install duplicate 3-wire units each of sufficient capacity to provide for the maximum unbalanced condition of the system.

The switchboard for a 3-wire generator is similar to that used with a 2-wire system, except that where compound-wound generators are used in parallel, 2 equalizer bus bars must be used. The connections of 2 and 3-wire generators for parallel operation are shown in Fig. 3.

Starting Compound Wound Generators Connected for Parallel Operation

SUPPOSE that generator No. 1, Fig. 2, is furnishing current to the bus bars and it is desired to place No. 2 in service with it; the following procedure should be carried out: First, get No. 2 up to speed; second, adjust the voltage of No. 2 as nearly as possible to equality with that of No. 1; third, close the equalizer switch then the main switches; fourth, watch the ammeters and by means of adjusting the field regulators or rheostats divide the load equally between the 2 machines.

If there are more than 2 machines, succeeding machines should be thrown into service similarly. In the

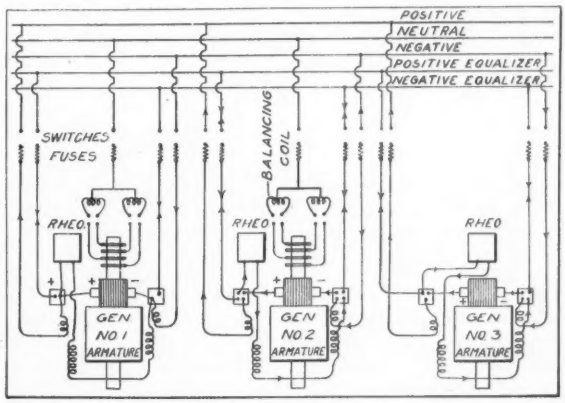


FIG. 3. SWITCHBOARD CONNECTIONS FOR PARALLEL OPERATION OF 2 AND 3-WIRE GENERATORS

event a generator is thrown in parallel with another one before its voltage is up to equality, it will be apt to take current from the other one and operate as a motor, in which case raise the voltage on the low machine by cutting resistance out of the field regulator or rheostat. If one of the machines carries too much of the load, move its brushes slightly forward, if it can be done without causing sparking.

Now, suppose that we wish to stop generator No. 2, Fig. 2; cut in resistance of the field regulator until the

ammeter shows a very slight load; then open the main switches and finally the equalizer switch, when the machine can be stopped. Be very careful that the shunt field circuit of the generator is not opened or broken while it is working in parallel with the other one, for the armature and series winding of one or probably both machines would be damaged unless they were instantly cut apart.

If it becomes necessary to increase the voltage of the line, all machines must be adjusted to that end. Normally, after the load is equally divided between the machines at a certain voltage, in the case of compound wound machines any increase of load demanded by the outside lines will be equally divided by the machines themselves and at the same time, they will maintain the voltage constant.

Instructions given for cutting in and out of service the machines in Fig. 2 will apply equally well for the 3-wire machines of Fig. 3. Machines must be kept dry, as any moisture on the commutator or armature will cause trouble.

Keep machines clean and free from oil and dirt. Any carbon dust or copper dust which may collect from the brushes should be cleaned off frequently. Be especially careful to see that no oil or dirt collects about the brush holders or the commutator. Keep all small pieces of iron such as bolts, nuts, tools, etc., away from the machines.

PARALLEL OPERATION OF ALTERNATORS

OVERCOMING TROUBLES WITH COMPOSITE WOUND MACHINES

By R. L. Mossman

AS THE operation of composite wound alternators in parallel generally causes more trouble with cross current and hunting than for machines that are separately excited only, I will explain how this difficulty was overcome on 2 machines of the composite wound type, that were driven by engines with

The Difficulty

THESE machines could be put in parallel without any trouble, but at times when the load came on the cross current would build up so that one machine would have to be pulled off, and as there were times when one machine could not carry all the load, it was

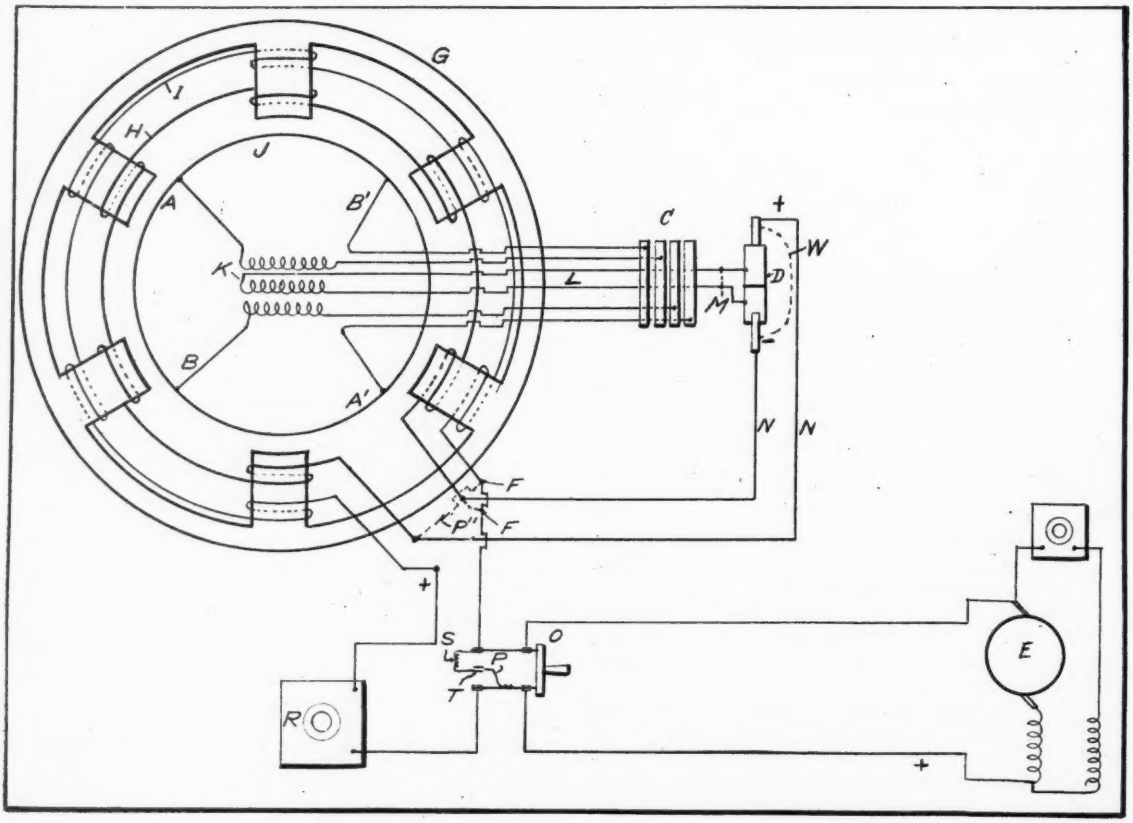


FIG. 2. WINDING CONNECTIONS OF A COMPOSITE WOUND ALTERNATOR

shaft governors which could not be adjusted while the engines were running. The generators were 150-kw. revolving armature type, 2-phase, 2200 volts, and were direct connected to their respective engines.

decided to change the winding and make the machines separately excited.

Before making any change in the generators, the indicator was applied to the engines when they were

running in parallel, and cards Fig. 1 taken. As will be seen engine No. 2 was carrying most of the load, caused by No. 2 engine running a little faster than No. 1 at no load, and having a speed variation of only about 1 per cent from no load to full load, while No. 1 had a variation in speed of about 2 per cent, so that the load on No. 2 had to be high to reduce the speed low enough for No. 1 to take its share.

I have found that if the governors are adjusted to give about 3 or 4 per cent drop in speed from no load to full load, the operation of the machines will be more satisfactory than if the speed variation is less. Some engineers are in favor of close regulation from no load to full load, which is all right for direct-current work, but for alternating-current work 3 or 4 per cent drop is better.

Proper Governing

FOR example, suppose that we have 2 machines, No. 1 and No. 2, which are to run at 200 r.p.m. at no load. As it is a hard matter to set both governors to act exactly together, suppose that No. 2 engine has a tendency to run a little over 200 r.p.m., say 201. If the governors are set to regulate on a 1 per cent drop from no load to full load, No. 2 engine will carry a greater proportion of the load, which will amount to ½ full load before No. 1 begins to take any load.

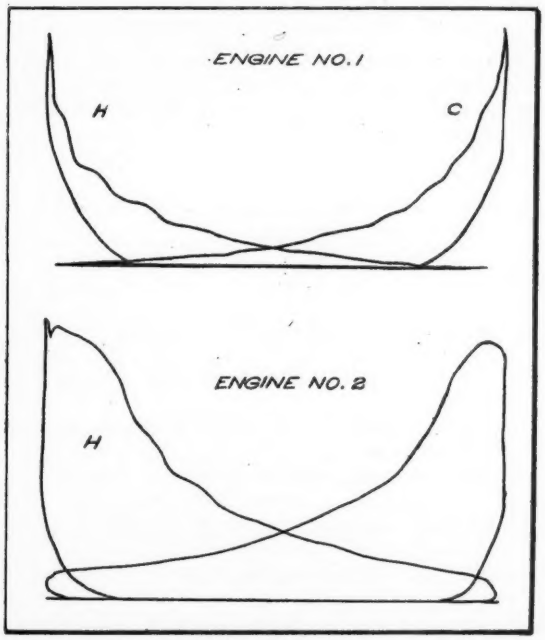


FIG. 1. INDICATOR CARDS FROM THE ENGINES DRIVING PARALLEL GENERATORS AS ORIGINALLY ARRANGED. SCALE 60; R.P.M. 201; BOILER PRESSURE 116; CYLINDER 17½ BY 18 IN.

On the other hand, if the regulation is 3 per cent, a very much smaller load on No. 2 will reduce its speed sufficiently to allow No. 1 to begin to take its share of the load. Before this condition is reached, No. 1 machine may be running as a motor, as the tendency is for the speed of No. 1 machine to be higher than it would be if not in parallel.

When 2 alternators having the same number of poles are running in parallel, they must run at the same speed, and if their engines do not keep them at this speed, the slow machine will be brought up and kept in step by the other one. The engine governors should be so adjusted that there is no tendency to cause a transfer or surging of the load from one engine to the other. This tendency may be caused by a sudden variation of the load, or by the angular variation of velocity in different parts of the revolution, which is common to most reciprocating engines.

If the governor is equipped with a dash pot, it should be kept full of oil thick enough to prevent the governor from being so sensitive as to respond to such disturbances, but still not thick enough to prevent the governor from acting when called upon to do so by a reasonable change in speed of the engine.

Composite Connection

FOR the benefit of engineers who have not had experience with the composite wound type of alternator Fig. 2 is shown, which is a diagram of the winding of a composite wound 2-phase machine. The generator field ring is shown at G, while H and I represent the auxiliary field and separately excited field coils respectively. J is the armature; A A′ B B′ the 2 phases brought out to collector rings C; K, a series transformer which is mounted in the armature spider and revolves with it, the secondary L, of this transformer being connected to a 2-part commutator D.

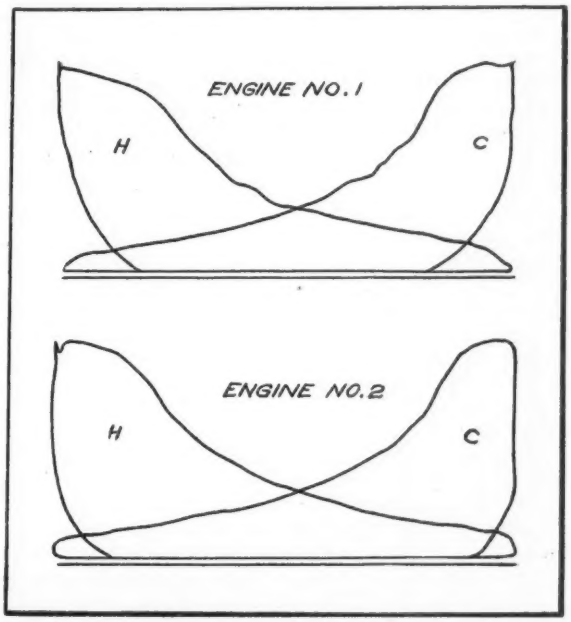


FIG. 3. CARDS TAKEN AFTER THE CHANGES WERE MADE. SCALE 60; R.P.M. 204; BOILER PRESSURE 100

The primary of this transformer consists of the leads A, B, which pass through the transformer and are connected to their respective collector rings C. The leads N, N, from the brushes on commutator D, go direct to the auxiliary field winding as shown; while the separately excited field I, is connected through the generator field rheostat R, to field switch O, thence to exciter E.

The type of field switch shown at O, is generally used to protect the field winding when the switch is opened. When a field circuit is opened, there is a momentary inductive kick or flow of current from the coils similar to the discharge from an induction coil,

the voltage of which is at times high enough to puncture the insulation of the field winding. When the switch as shown at O, is used, the fields are short circuited when the switch is opened, by the piece P, entering the clips T, which are connected to the side of the switch as shown by a resistance S, allowing the discharge to pass through the resistance and preventing the sudden rise of voltage in the field coils.

Action of Compounding Coils

THE compounding effect of the auxiliary field in this type of machine is the same as the series winding of a compound-wound, direct-current machine. When the load increases the increased flow of current through the primary of series transformer K, causes an increased flow in secondary L, which passing through the commutator is changed to direct current, and flows through auxiliary winding H, increasing the strength of the fields and holding up the voltage. When load is reduced, the opposite takes place, less current flows, which weakens the fields and prevents an increase of voltage above normal.

In setting the brushes on the commutator D in a non-sparking position, care must be taken that the current from the brushes does not oppose the current in the separately excited fields; this will be noticed by a decrease in the voltage, and rocking the brushes one segment ahead or back will correct this.

The Changes Made

AFTER the engines were adjusted, the machines were put in parallel and they ran much better than before the speed variation was increased, but as the cross current or hunting still gave trouble it was decided to try the machines with the composite winding cut out. As the exciters were loaded to only 60 or 70 per cent of their capacity, the brushes on commutator D, were short circuited as shown by dotted line W, thus cutting out the self-excited field, and exciting the field of the alternators from the exciters alone.

Machines were run in parallel for several days in this condition in order to note whether any cross current developed; as the machines ran all right, the leads N, N, from the brushes were removed, also brushes and brush holders, and the auxiliary winding H, was connected in series with winding I, as shown by dotted line P″. The negative lead of the exciter was connected to one terminal of winding H, as shown by dotted line F.

This reduced the load on the exciters. The secondary leads L, from series transformer K, were short circuited at M, where they entered the commutator D. After this change was made any cross current that showed up, was caused by poor regulation of the engine governors, and could always be eliminated by proper attention.

In changing the winding and connecting the 2 field coils in series, care must be taken not to have the windings oppose each other. This change in the winding is also necessary if the machines are to run in parallel with a revolving field separately excited machine.

The Result

THE cards shown in Fig. 3 were taken after the engine governors were adjusted. Though No. 2 engine is carrying more load than No. 1, as is shown by the cards, the load was equalized by decreasing the tension on the governor spring on No. 2, and increasing it on No. 1 governor.

CHEER UP, OLD MAN, CHEER UP!

By George H. Wallace

Did you ever feel that everything is going straight to smash?
That the sun is turning backwards and into the world will crash?
Did you ever feel like that, my friends—you engineers and such?
Well, if you did, hang on a while, some friendly hand will touch
You if you smile, man, smile.

When the boss is cross and grouchy and keeps you on the go;
When the fireman is slouchy, and the engine's running slow;
When the draft is faint and feeble, and the pump begins to race;
When you long for your vacation and your troubles haunt your face,
Why, smile, man, smile!

When the piston rod needs packing and is scored to beat the band,
And the pins and bearings heating like they had been greased with sand;
When the governor still refuses to perform its level best,
Forget your load of trouble, go sit you down and rest
And smile, man, smile!

When the lubricator's buckin', and the grates are broke in two,
The condenser's lost its vacuum—the injector hot and blue;
When the water glass is empty and the whistler plays a tune,
Fill up your pipe and smoke it, you will get your reason soon
If you smile, man, smile!

Don't let anybody bluff you. Tell them all to go to—grass;
When the boss brings in some expert to untangle all that mass,
Let him go and fix the office if he really wants a case,
But tend right to your knittin' just as if you owned the place,
And smile, man, smile!

Don't fly off the handle every time a thing goes wrong,
If the belt runs off the boiler, why, sing a little song;
If the junkvalve breaks to pieces, or the doogan pin gives way,
Fix it up and keep on running, like it happened every day—
But smile, man, smile!

When the dash pots all get cranky and the heater's on the bum,
The cylinder needs reboring and the stoker will not hum;
When the blow-off valve is leaky and the boiler bursts a flue,
Don't let anything disturb you, for, old man, it's up to you,
So smile, man, smile!

Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

Inspection of Boiler Plate

IF you were detailed to inspect the manufacture of a quantity of boiler plate and found that these plates were being made by the Bessemer process while open hearth was specified, would you accept the plates or reject them, and what would be your reasons for your course?

2. What is the difference between basic and acid process of manufacture and what is the relative value of the product? L. R.

Zinc for Boilers

HAS anyone had any experience with trying to clean flues, tubes and stack of a return tubular boiler by putting a mass of zinc into the fire while running? K. R.

Smoke Stack

I HAVE a 50-ft. smoke stack to put up this season and have never had any experience in such work and do not know how to do it, as our boiler room is very low and the stack passes through the roof about 8 ft. from the edge of the wall. I would like to have the opinion of the readers of Practical Engineer. J. W. M.

Filtration Plant Record

IN our city a filtration plant is to be installed and I am wanting a form for daily reports such as readings of different gages, time of cleaning filter, etc. Can any readers of Practical Engineer in charge of a filtration plant suggest something suitable? P. C.

Brake Band Lining

IN regard to the inquiry about a brake band lining I would state that in my experience of 15 yr. there is nothing better than Gandy belting or any good brand of that same type. It can be put on the inside of a wood-lined band or riveted to the brake band, according to the make of the brake. One thing that is of importance is to have the drum or disk perfectly true for the band to work on. E. B. Williams.

Referring to A. R.'s question regarding Brake Brand Lining in a recent issue of Practical Engineer, I will say that I have had considerable experience in the use and application of friction band linings, and the best material I have found to date is an asbestos friction lining manufactured by the H. W. Johns-Manville Co. called J-M. Non-Burn.

I have used this material on both hoisting engines in coal mines and on ore handling machines at the local ore docks, and have found it to be by far the best lining I ever used, it is far better than wood blocks, leather or Gandy belting.

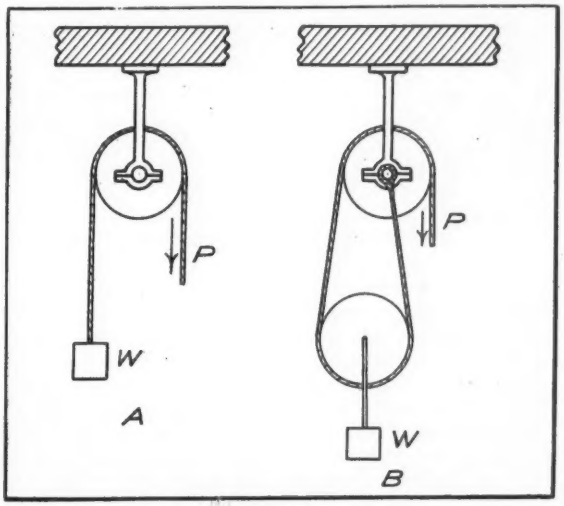
I have been able to get from 5 to 7 times the wear out of asbestos lining that I could from the best basswood blocks.

If A. R. will secure an asbestos lining and apply to his steel band with copper rivets spaced on about 3 in. centers he will have a band which will work perfectly smooth and will not jump or slip as his present one does.

A lining from a large ore handling machine which has seen a full season's service was originally ½ in. thick and is now about ⅛ in. H. McKinley.

Best Pulley Arrangement

BELOW is a sketch of a pulley problem. Pulleys A and B both have a 1-in. rope passing over them; suppose that the 1-in. rope has a breaking strength of 7000 lb., would pulley B be able to sustain twice the weight as pulley A? Or, if the strength of the rope passing over pulley A equals 7000 lb., would the rope passing over pulley B equal 14,000 lb?



SINGLE AND DOUBLE LIFT

A. On the pulley A, which has the single rope passing over it, the rope must carry the full weight W, and P, the sustaining force, must equal the weight. The pull on the hanger that supports A would, therefore, be twice the weight, and the strain on the rope would be equal to the weight.

In the case of pulley B the weight W is supported by 2 strands of rope, and on each of these there would be a strain equal to ½ W while the supporting force P would also be ½ W. The downward pull on the hanger which carries the stationary pulley would, however, be 1½ W, because with the force P acting downward there would be a downward pull by 3 strands of rope, each having a strain on it equal to ½ W, or a total of 1½ W.

Taking your figures, if you had 1-in. rope with a breaking strength of 7000 lb., the weight W which could be carried on an arrangement of A would be 7000 lb., while the weight W which could be carried by the arrangement B would be 14,000 lb.

Generators in Synchronism

IF 2 alternators are in synchronism and the exciter voltage goes down to almost zero can they be brought up again with the same exciter with safety? R. H. H.

A. The exciter voltage does not in any way affect the synchronism of 2 alternating current generators, provided the exciter furnishes current for both generators. In order that alternators shall synchronize it is necessary that the voltage in each machine is the same and that the alternations per minute of each machine are the same. It does not destroy synchronism, therefore, to lower the voltage on both machines equally and at the same time, so that they may be brought up again after the voltage of the exciter has decreased to zero, with entire safety, care being taken to have the voltage of both machines increase equally and at the same time. This condition can be secured by maintaining the proportionate load on each machine.

Hoisting Engine Queries

A HEAVY weight is to be placed on the hoisting cage of a coal mine and lowered to the bottom of the shaft. How will the engineer hold the cage in case it cannot be held by the friction brake that is on the drum of the engine?

2. What is the object in connecting a release valve to the throttle valve of a hoisting engine, and what is it used for?

3. An engine having a cylinder 14 by 24 in., using 60 lb. of effective steam pressure per square inch, is direct connected to a drum 8 ft. diam. Neglecting friction of the engine, how much will the engine lift in pounds? E. E. H.

A. If brake on drum is not sufficient, by reversing the engine and admitting just enough steam to keep it in check.

2. A release valve is connected with the cylinder and is used to let out of the cylinder steam that has got there through a leaky throttle when the engine is supposed to be at rest. It is also opened to let steam out of cylinder when reversing large engines and it would be a problem to handle some makes of hoisting engines without one.

3. It appears that this is a single engine and the load it will just be able to hold in balance will be equal to pressure times the area times the length of crank divided by the radius of drum; $14^2 \times 0.7854 \times 60 \times 1 \div 4 = 2609.076$ lb. Note that the power must exceed the load before there can be motion. The above result is called the turning moment of the engine. If you double the velocity of the load, it requires the engine to exert double the power so that the load an engine can hold in balance is greater than the load to which it can impart motion.

As a rule most hoisting engines of large size are double , but in figuring out what they will lift, even when stated as double engines, there is only one engine cylinder calculated, because it requires that amount of pull to start the load, there being no slack in the ropes; when there is slack mentioned, use the rule following and by transposing you can find the size cylinder required when load is known, or size drum when cylinder and load are known.

Multiply the pressure by the area, and by twice the stroke; this gives the work done in 1 revolution which equals the load times circumference of the drum.

Water Fog Condenser

IN a new mill which is being built we will install a 2000-hp. cross compound condensing engine. The river is 1200 ft. from the power plant and the lift is 25 ft. What size suction pipe would we need to supply the air pump? We could reduce the lift by placing the air pump in a pit, but would like figures on 25-ft. lift. If we should put a reservoir in the mill yard, what amount of water would be required for the 2000 hp.? What horsepower would be required to pump the water to the reservoir against the 25-ft. head, and what would be the most economical pump to use under the condition mentioned? How would centrifugal pumps do, driven by electricity? C. B. G.

A. A cross compound condensing engine of 2000 hp. capacity should require about 15 lb. of steam per hour per horsepower, or 30,000 lb. per hour all together, and for a surface condenser, which I presume you will use, the condensing water required will be about 40 lb. per pound of steam condensed, or 1,200,000 lb. per hour. This would be 144,000 gal. per hour or 2400 per minute.

Assuming that the circulating pump ran at 50 double strokes per minute, and double acting, this would mean 24 gal. per stroke and would call for a 16 by 24-in. reciprocating pump. If a centrifugal pump were used, one which rates at about No. 12 with a 12-in. suction pipe would be suitable and for your conditions and would be quite as satisfactory as reciprocating.

The same sized suction pipe would be required whether the pump were centrifugal or reciprocating. This would be the size connection to the pump, but for as long a run as you have it would seem desirable to put in a larger pipe on account of the friction.

There is a nice question involved here as to cost of power as against extra investment in pipe, and that could only be settled by knowing prices and local conditions. As a matter of good engineering it would seem advisable to use a 14-in. suction pipe.

As to the power required to lift 20,000 lb. of water per minute through a distance of 25 ft. and assuming an efficiency of operation of the pumps of 85 per cent, would require $20{,}000 \times 25 \div 33{,}000 \times .85 = 17.8$ hp.; 20 hp. would probably be required, however, on account of the length of the suction pipe.

Material for Expansion Tube

I CONTEMPLATE using an expansion tube for a particular purpose, what material is best? Can I get any material that will lengthen about ¼ in. in 3 or 4 in. when subject to change in temperature of 173 deg. F.? How can this material be made (if alloy) or where could I procure it? E. W.

A. It is impossible to get any material which will do what you want. The amount of expansion of any alloy in length of 4 in. would be only some hundredths of an inch.

A method which you might use would be the construction of a curved tube such as is used in the Marck steam trap. This is a tube of the same kind as is used in a steam gage but is sealed and filled with a volatile liquid. By this means when heat reaches the tube the liquid is evaporated and puts pressure on the inside of

the tube, tending to strain it and when the tube is cooled the liquid condenses, and the pressure being relieved the tube contracts. This involves space enough to get in a U bend.

Another method which might be used is that of the expansion couple in which 2 metals with different coefficients of expansion are soldered together. One of these expands very rapidly with heat, the other slowly. You will see that when a strip like this is subjected to heat the piece which elongates rapidly will warp the combined strip, and if one end of the strip be made fast the other end will be swung to one side and, of course, on cooling the opposite effect ensues. You would here have to have length enough at one side of the line where you want movement to take place, so that you could get a strip of the required length to give ¼ in. movement and have room to fasten it. A quarter inch is a good deal to get by any expansion method in confined space, and you will have trouble with getting this in any way except by the expansion tube already described.

Steam Shovel Engine

KINDLY explain the operation of the valves on a steam shovel engine. J. W. M.

A. This is practically a double engine and is arranged the same as the carriage feed on a saw mill engine, to reverse without moving the eccentrics. There is a valve in the center between the 2 steam chests which controls the entrance of steam to the cylinders. In one position this drives the cylinders in one direction; in the other position it drives them in the opposite direction.

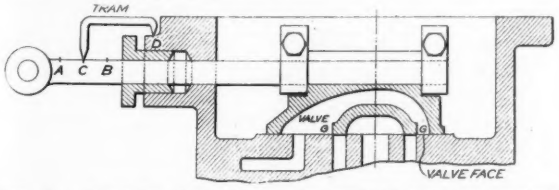


FIG. 1. SECTION OF VALVE FOR STEAM SHOVEL ENGINE

The valves which control the steam are plain D valves and the eccentrics are set so as to give the required lead. The engines take steam for practically full stroke so that the eccentric position is about 90 deg. ahead of the crank pin.

In regard to the steam shovel engine, the valve is made as shown in Fig. 1, a valve being provided for

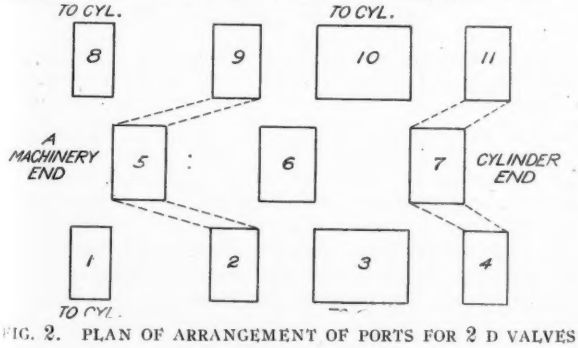


FIG. 2. PLAN OF ARRANGEMENT OF PORTS FOR 2 D VALVES AND REVERSING VALVE

each cylinder. The action of the valves is as follows:

Figure 2 shows the plan of the ports, 8, 9, 10 and 11, corresponding to 1 cylinder, and 1, 2, 3, and 4 to the other cylinder of the double engine. Ports 5, 6, and 7 are the reverse ports, and are controlled by a piston valve which may be set in any one of 3 positions: First: Leaving 7 uncovered, and connecting 5 and 6 in the go-ahead position. Second: Leaving 5 uncovered and connecting 6 and 7 in the reverse position. Third: Mid position covering both 5 and 7, which will stop the engine.

Taking the cylinder to which ports 8, 9, 10 and 11 correspond, assume that the piston valve is set as in the go-ahead position with port 7 covered, and 5 and

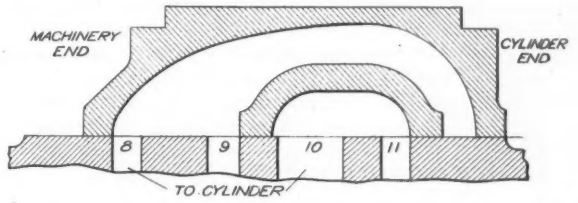


FIG. 3. STEAM VALVE ADMITTING TO RIGHT-HAND END OF CYLINDER FOR GO AHEAD

6 connected, and that the valves stand as shown in Fig 3. Steam will then pass downward through port 7, through the passage shown dotted in Fig. 2, to port 11, up through this and under the valve to port 10 and down that to the cylinder.

On the other end steam is exhausting from port 8 into port 9, then through the dotted passage of Fig. 2 to 5 and across under the piston valve to 6.

When the valve moves over to the position shown in Fig. 4, the position of the steam will be reversed.

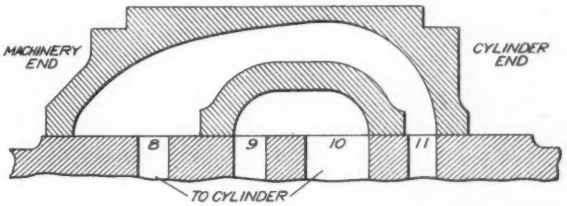


FIG. 4. STEAM VALVE POSITION FOR LEFT-HAND ADMISSION, GO AHEAD

Steam still comes from 7 to 11, then up through 10 and through the passage in the valve to port 8, through which it enters the cylinder, meantime, from the other end steam is passing out of port 10, into port 9, under to 5 and across to the exhaust 6.

If now we shift the piston valve so that steam enters 5, and 7 and 6 are connected, we have the reverse set of conditions. With the valves standing as in Fig. 3, steam will enter 5, pass up through 9 and down 8 to the cylinder, while the exhaust will come from the cylinder through 10 to 11, across to 7 and out through 6. With the valves shifted as in Fig. 4, steam will enter through 5 and 9, pass into the cylinder through 10 and exhausting from the cylinder through 8 will pass through the valve to 10 and out through 7 and 6. The action of the valve for the other cylinder which operates ports 1, 2, 3, and 4 will be exactly the same.

In setting the valves the method to pursue is as follows: First: Turn over the crank shaft and find the full travel of the valve stem ahead. Mark the stem at A with a tram from the point D on the stuffing box. Be sure that this point D is not on the gland.

Second: Turn the crank shaft back full travel and mark the stem at B with the same tram point from D.

Third: Find the center of the distances AB at the point C and this when set to the tram point will give the valve in the middle position.

Fourth: Turn over crank shaft till the point C comes to the point of the tram and the valve stem will be at the center of its travel. Then mark the cutting edge of the steam ports of the valve setting and mark the cutting edge on the side of the valve GG. Place the lines G so that they match with the lines on the seat and tighten the clips on the valve stem and the valve is set.

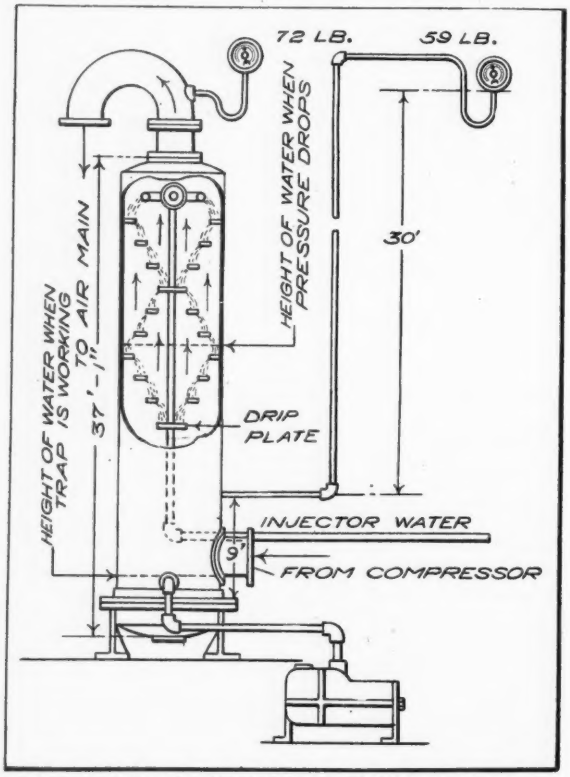
The same directions apply to setting the valves in boom and swing engines for a steam shovel. For the hoisting engine valves the setting is the same as for any D valve engine which has lap and lead.

KINKS FOR THE PLANT

Air Cooler

THE cut represents an air cooler for a mine used in connection with a 24,000-cu. ft. per min. compressor, driven by a 7000 hp. steam unit. This cooler has 2 vertical sets of drip pans, in step form, extending from the bottom to the top.

Injection pipes are arranged to permit the water to strike on the upper pans and drip from one pan to another while the air passes through it.



SECTION AND ARRANGEMENT OF CONNECTIONS OF AIR COOLER

This cooler stands outside the building and cools the air for the last time before entering the underground main which leads to the mine. The air temperature on entering this cooler is 200 deg. F., and while passing through this cooler the temperature is lowered to 70 deg.

When the trap connected to the cooler fails to work, the water will rise over the gage pipe which is 9 ft. from the bottom. How much higher the water rises I do not know, but at this joint the gage will drop to 59 lb. while the main pressure shows 72 lb.

As that pressure shows going down the engine is speeded up. It is then my attention is called by the poppet valve, which is on the main pipe, blowing and the gage shows 72 lb. while the gage on the cooler shows 59 lb. We then discover that the cooler is flooded.

I would like to hear from some of the readers of the Practical Engineer, giving the cause for the difference in pressure. I think I know the cause but would be interested to hear what others think.

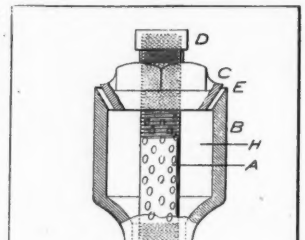
Joseph S. Soddy.

Blower Head for Boiler Stacks

WHEN draft is insufficient in a boiler stack to carry the maximum load on the plant and must be helped out either temporarily or at certain periods during the day, a device such as shown herewith will oftentimes save the day. The one described was made to serve the stack for a 60-hp. return-tubular boiler and was first made by Herman E. King, who furnishes the description to the Canadian Manufacturer.

A 2 by ¾-in. coupling was bored out, conical as indicated, at the large end and threaded at the small end. A piece of ¾-in. steam pipe, A, was cut of length to reach through the bottom of the coupling and extend 1½ in. outside the large end of the coupling. A long thread was cut on the upper end and the body of the nipple drilled with holes as indicated.

To form the cover a reducing bushing was turned down to cone shape, as at C, and screwed on the ¾-in.



CONICAL-JET BLOWER FOR STACK

pipe, a ¾-in. pipe cap being put on top at D. The holes drilled in the ¾-in. nipple were 20 ¼-in. to allow steam to pass into the body of the coupling. The reduction bushing was screwed down as shown, until the space at E was 1/32 in. wide. The whole device was then mounted with an elbow on ¾-in. pipe and connected with the steam main from the boiler. This gave a conical jet of steam, the idea being to catch all the air inside the stack and force it upward whereas a simple steam jet from the end of a pipe would set in motion only the air and gas in the center of the stack.

Engine Repairs

FIGURE 1 shows a rocker arm for the exhaust valves of a tandem compound Corliss engine which got hot and stuck to pin so that it could not be pried off. It was heated with blow torches and pried but it would not move, and it was then decided that the hub of the rocker arm would have to be split to get it off.

As the engine was needed and had no other rocker arm, care was taken in getting it off without breaking it, ¾-in. holes were drilled ½ in. apart on top of the hub, down to the pin as shown at A, Fig. 1. Round wedges were made and one put in each hole and each was given a hit in rotation until the hub cracked from hole to hole. It was then pried off, the wedges taken out, and hub scraped, and the pin was filed to a smooth surface.

A band of wrought iron was made a trifle smaller than the hub, then was heated and shrunk on so it held the crack closed, as shown in Fig. 2. Babbitt was melted and poured into the holes that were drilled, except one that was used for an oil cup, and those covered by band.

Grease was being used and was forced in from bottom side of the hub, but oil was thought best to

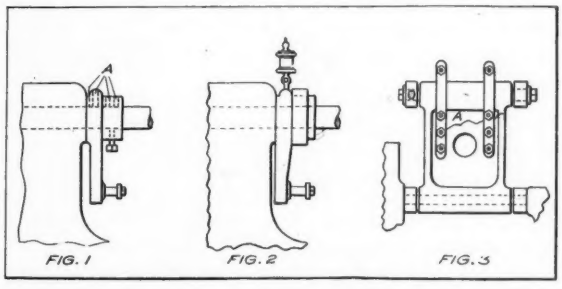


FIG. 1. METHOD OF SPLITTING THE ROCKER ARM HUB
FIG. 2. THE RING SHRUNK INTO PLACE ON THE HUB
FIG. 3. MENDING A CRACKED ROCKER ARM WEB

use so as to feed more regularly, and you can tell by looking at the oil cup whether it is feeding by the amount the oil has gone down in the cup since it was filled or last time it was looked at.

The rocker has now been used for over a year and works as well as it did before it got hot, except that it is a little looser, on account of being scraped and the pin filed.

Another Corliss engine which had a rocker arm a little different from the one above mentioned, had a crack as shown at A, Fig. 3, from some cause unknown; it was discovered by grease working out of the crack. The engine was running at the time and could not be shut down as the engine in reserve had the cylinder heads off and new piston rings were being put in.

Two clamps were made of wrought iron, and when the engine could be shut down they were put on as shown in Fig. 3, which kept it from cracking across.

Engineer.

Practical Hints on Piping

FOR a number of years I have had charge of the piping of all kinds of a shop that has increased its output 1000 per cent, which has kept us busy putting up and tearing down systems of piping.

We feel that we are not professional pipe fitters and designers of systems but experience knocks something into the dumbest head. One of the kinks that has given us the most pleasure is a pipe cart. It consists of 2 old cultivator wheels spaced about 3 ft. apart on a 1½-in. axle. The wheels are about 36 in. in diameter, a 1½-in. pipe frame extends 2 ft. on one side of the axle and 4 ft. on the other side, the long side being for handles and supplied with a pair of legs, and a platform is built on the frame.

Three men can take a length of 10-in. pipe anywhere in the yard or buildings with no more exertion than they would a length of 2-in. without it, also when they are going out on a job I notice they throw their tools and fittings on the cart. After we have added some convenience to our list we wonder how we got along without it and why we were so stupid as not to think of it sooner. So it is with the cart.

Oftentimes in running a line of pipe in a trench or cramped places we come to a place where we have a right angle or 45-deg. bend to make. Experience has taught me to start off from the bend with a short piece 4 or 5 ft. long; this gives a sighting piece to line up a long length by. I assure you it will help anybody a lot in getting away on the line.

In laying pipe either overhead or under, accurate measurements tend to bring you out where you intended, at the same time it is impossible to make your lines come up to the measurements every time for reasons that cannot be controlled by the fitter. No one can tell beforehand whether the fittings will make up well or whether it is a tight lock that has to be forced to get the pipe in. So it is a usual practice to leave 1 piece uncut, to allow for this uncertainty of how it will make up or whether the threads are straight.

In building wall coils for heating whether mitre or corner work, the shortest spring piece, that connecting to the branch tee should not be less than 24 in. for 1¼-in. pipe, if less it will break the tee, pipe or ell. If everything worked according to theory it might not but it don't. It may so happen that the top rows of pipe will get hot while the bottom rows are cold, then you have theoretically a difference of 1.92 to 2.5 in. in length per hundred feet between top and bottom pipes; if the pipes are not crooked something is going to break. We got this in our usual way of acquiring knowledge by hard knocks.

The shortest distance between 2 points is a straight line but we don't run our pipes that way unless they are for cold water; for steam we usually like a few crooks properly distributed.

Some of the brothers seem to be troubled with vibration of their steam pipes to their engine; if there is anything that will set a steam pipe to joggling it is an automatic cutoff engine especially a Corliss with a big diameter and short stroke. We had an experience of this kind when using 3 horizontal tubular boilers connected to a 14-in. drum through nice long bends and the same kind of a bend to the engine. This arrangement shook the brick work all to pieces in 3 yr.; we had it braced and anchored to everything in reach, but to no avail.

We got it so we could live with it by putting in a receiver close to the engine coming down to the receiver with a fair radius bend and from the receiver to the engine with a U bend. After this we usually found the boilers where we expected to, but we had to put a strut and tie between the legs of the U to keep from shaking the head off the receiver.

CORRECTION

H. Ross Callaway, author of the article on Turbine Driven Centrifugal Pumps in the February issue, has called attention to an error in the caption of one of the cuts. The pump which was spoken of as being manufactured by the Platt Iron Works was built by the Jeanesville Pump Co., of Jeanesville, Pa.

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CONTENTS

Westinghouse-Leblanc Refrigerating Process. Illustrated...197
Drainage of Piping. Illustrated.....201
Are Steam Traps Economical? By M. T. Simpson.....204
Wash Boiler Day.....204
Boiler Strength and Horsepower. Illustrated.....205
Smokeless Firing Tests in Government and Private Plants. By Carl S. Dow.....207
Coal Handling Plant of the La Salle Hotel. By H. H. Kress. Illustrated.....208
A New Gas Producer. By W. A. Tookey. Illustrated.....210
Ignition and Engine Efficiency. By Roger B. Whitman.....212
Thermostatic Controlling System. By Charles Mandeville. Illustrated.....216
Sources and Methods of Production of Lubricating Oils. By W. A. Converse.....218
Typical Small Central Station. By P. A. Boyd. Illustrated.220
Selling Light, Heat and Power in Milwaukee.....221
Details of Power Plant Design. By Charles L. Hubbard....222
Facts of the Pittsfield, Mass., Explosion.....223
The Institute of Operating Engineers.....224
Boiler Explosion at New Lexington, Ohio. Illustrated.....225
Letters from Engineers: Singular Gas Engine Crank Shaft Failure. Knock in Pump. Flow from Tank. Care of Idle Boiler. Use of Steam Loop. Wasting Waste. Leaking Water Fronts. Taming a Bearing. Peculiar Gage Trouble. Pump Regulator. Automatic Governors. Peculiar Indicator Diagram. Splicing Belts. Card Cement. Cutting Gage Glass. Polishing Shafting. Secure Packing for Flange Joints. Illustrated.....226
Operation Hints. By John C. Kahl. Illustrated.....232
Parallel Operation of Alternators. By R. L. Mossman. Illustrated.....234
Cheer Up, Old Man, Cheer Up! By George H. Wallace.....236
Questions and Answers: Inspection of Boiler Plate. Zinc for Boilers. Smoke Stack. Filtration Plant Record. Brake Band Lining. Best Pulley Arrangement. Generators in Synchronism. Hoisting Engine Queries. Water Fog Condenser. Material for Expansion Tube. Steam Shovel Valves. Illustrated.....237
Kinks for the Plant: Air Cooler. Blower Head for Boiler Stacks. Engine Repairs. Practical Hints on Piping. Illustrated.....241
Editorial: Plant Efficiency. Isolated Plant Association.....242
Steam and Exhaust Pipe Charts.....243
Association Meetings.....243
Bristol's Compensated Gas-Filled Recording Thermometers. Illustrated.....244
Removing Soot from the Green Economizer. Illustrated....245
Determining Accuracy of Indicator Springs. By E. K. Uebe. Illustrated.....246
A Tube Cutter and Expander. Illustrated.....247
Economical Steam Transmission. Illustrated.....248
Death of Wm. B. Mason. Illustrated.....249
Louis Ross Alberger, Deceased. Illustrated.....249
News Notes.....249
Catalog Notes.....250
Trade Notes.....253

PLANT EFFICIENCY

Since Lawyer Brandeis sprung his now famous proposition to save the railroads of the country $300,000,000 a year odd, the matter of scientific management and labor efficiency has come strongly to the front in magazine articles. Started as a method of reducing the cost in operations where the same work is done over and over again, this method has been applied in nearly all branches of work, and though the form and details must be changed for every situation, the principle has been proved applicable to almost any kind of activity.

The fundamental points are: First, to provide working facilities which will eliminate all unnecessary operations. Second, to determine by careful study the order of operations in doing work to make them most effective and the time in which each operation can be performed by attention to business without fatigue. Third, to provide some incentive for performing the work by the method desired and a reward for reaching the result determined as possible.

The application of these fundamentals rests, as does the carrying out of any scheme, with the manager of an organization. He may be foreman in a shop, chief engineer in a plant, or chief clerk in an office.

In the most efficient establishments of any of these types it will be found that scientific management has been developed to a certain degree, but in most of them it has been largely a matter of intuition on the part of some one man and not a matter of careful study, with a definite idea of applying these fundamental principles.

These principles apply as much to the working of machines as to the working of men. A machine will evidently do its best work when it is so arranged that it has the best chance, when the method of running it has been studied so that it is handled in the most efficient manner and when a suitable reward in the way of care or shutdown for overhauling is provided in order that it may continuously work when in service at its highest speed.

The working out of these different points in detail requires long and careful consideration and we feel that this may well be taken up at length by each engineer in his own plant.

In order to bring out discussion of problems which are of direct practical value, we would be glad to have from any subscriber a statement of conditions which he would like to better in as complete detail as possible, with the object of trying to solve these problems one by one, both to show the application of the principles as laid down and to help the individual man in his daily work.

ISOLATED PLANT ASSOCIATION

Formation of this association is to be welcomed for the work planned, so far as stated in its published literature, is needed. Central stations have reasonably accurate standards of what constitutes good performance in the cost of production of the horsepower-hour or the kilowatt-hour. Isolated plants are run under different conditions and in but few cases are there records which can serve as comparative standards of performance.

The securing and compilation of statistics in these lines will be of greatest assistance in showing the economy which the isolated plant has as compared with the central station, and in giving engineers in isolated plants a standard of performance to which they may work.

STEAM AND EXHAUST PIPE CHARTS

THESE curves are prepared by W. J. A. London, Chief Engineer of The Terry Steam Turbine Co., Hartford, Conn., to save the necessity of working out the size of steam and exhaust piping for each individual installation.

Having given the power, water rate and steam pressure, size of steam pipe is obtained as shown in the example on curve No. 1, Practical Reference Tables: Thus, assume 300 hp. at 30 lb. water rate, with 175 lb. initial pressure. Follow up the 300 line to the 30 lb. water rate diagonal, and from the intersection run to the right to the initial pressure diagonal line, and in the example this is between 3 and 3½ in. pipe, and will therefore take the larger size.

For determining the exhaust outlet when given the power, water rate and back pressure or vacuum, proceed from curve No. 2, in exactly the same way.

The steam pipe sizes are based on the standard steam velocity of 100 ft. a second or 6000 ft. a minute, using dry saturated steam. The exhaust curves are based on velocity of steam of 400 ft. a second or 24,000 ft. a minute for all vacuum diagonals, or about 100 ft. per second, 6000 ft. per minute for atmospheric exhaust vertical line.

In all these exhaust curves, steam has been taken as expanding from 150 lb. gage, and from Peabody's steam tables, which have been used throughout the calculation, this gives an entropy of 1.56. In cases where the initial pressure is different from that stated, a small correction should theoretically be made for the difference in moisture, but the percentage difference in ordinary work in expanding from 200 lb. to 1 lb. absolute and from 100 lb. to 1 lb. absolute is so small that the curves will be found sufficiently close for all practical purposes.

All pipe diameters given are based on net internal areas. As the net areas of extra heavy pipe and double extra heavy pipe are very often considerably less than the normal diameter of pipe, corresponding allowance should be made, as per areas given in the Practical Reference Tables on piping dimensions.

ASSOCIATION MEETINGS

THE NEW YORK BRANCH of the Institute of Operating Engineers will hold its second monthly meeting on the evening of March 9, 1911, in its rooms in the Engineering Societies Building, 29 W. 39th Street. Wm. D. Ennis, professor of mechanical engineering of the Polytechnic Institute of Brooklyn, will read a paper on the Commercial Aspect of the Work of the Operating Engineer, and other prominent engineers will enter the discussion of this paper.

FROM YAZOO CITY, Miss., comes the news of the organization on January 26th, of Colonel Goethals Branch No. 1 of District No. 9, of the Institute of Operating Engineers, with a charter membership of 13. The officers elected were Branch Chairman, F. C. Holley; Secretary and Treasurer, L. B. Smith; Councilmen for 3 years, F. C. Holley, W. W. Brannon, W. C. Richardson; for 2 years, Davis Chisholm, W. R. Vernon, and Albert Walker; for 1 year, Ray Madden, Wince Hoover, and Mr. Parks. Lecturer on Apprenticeship Training and Plant Operation, W. C. Richardson; lecturer on Educational Subjects, W. W. Brannon. Messrs. Vernon and Walker were appointed assistant lecturers on Apprenticeship Training and Plant Operation, and Messrs. Walker and Chisholm as assistant lecturers on Educational Subjects. Meetings of the branch are to be held on the second and fourth Saturday nights of each month. The address of the Secretary is L. B. Smith, P. O. Box 297, Yazoo City, Miss.

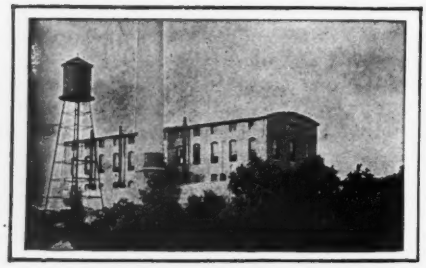
ON APRIL 10 AND 11, there will be held in Boston, the Congress of Technology, in commemoration of the 50th anniversary of the chartering of the Massachusetts Institute of Technology, and also for the purpose of summarizing the development in the varied lines of engineering in which graduates of the institute have been engaged. This summary will be by means of a series of papers, written by the different men most successful in their special lines, and will discuss present conditions and future prospects in specific industries. The meetings will be open to the public.

ON MONDAY EVENING, January 30, a meeting of the National Isolated Plant Association was held at the Engineering Societies Building, in New York City, a constitution was adopted and permanent officers were elected as follows: President, C. G. Armstrong, of New York City; Vice President, F. E. Stiles, of New York City; Secretary, E. B. Fieux, of New York City; Treasurer, W. B. Elliott, of Garwood, N. J.; Council, Mr. Buxton, an operating engineer; Mr. Kimball, a consulting engineer; Mr. Ferguson, a manufacturer; Mr. Katten, a salesman, and Mr. Elliman, a plant owner. The committee on the admission of members is made up of Mr. Dalbec, Mr. Wing, Mr. Torrance, Mr. Spooner of the Ridgeway Dynamo & Engine Co., Mr. Edgerton, Mr. Bierck and Mr. De Gress of the Crocker-Wheeler Co. No initiation fee is charged the operating engineer, and his dues are $2 a year. For others, the initiation fee is $15 and annual dues $10. It is planned to make a complete test of numerous isolated plants now in operation, so as to collect cost data as an offset to figures presented by central stations.

ARRANGEMENTS HAVE NOW been perfected by the Central States Exhibitors' Ass'n. of the N. A. S. E., to handle the exhibits at the following state conventions during the year 1911: Illinois, Iowa, Indiana, Kentucky, Minnesota, Missouri, and Wisconsin. The charge for members who exhibit at every convention will be $10 for each convention, and the associate members who exhibit at one or more conventions will be $12.50 for each convention. For this charge one booth will be supplied, all booths being uniformly decorated in the state colors, and a sign will be furnished, all signs to be of uniform size, but other signs will be allowed.

Each exhibitor will be furnished a copy of the official bulletin, one exhibitor's badge, and will be allowed a vote at all regular meetings held at the time of the convention. The giving of souvenirs, except articles which are a part of the exhibitor's product, trade marks, catalogs and circulars, is discouraged. All expenses are to be met out of membership fees, no special assessment being levied, and any balance left on hand at the end of a state convention will be turned over to the state association of the N. A. S. E.

Those wishing to arrange for exhibit space at any of the above named conventions should communicate with the secretary, E. T. Gould, 1836 Berwyn Ave., Chicago.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

BRISTOL'S COMPENSATED GAS-FILLED RECORDING THERMOMETER

DURING the last 15 yr. Bristol recording thermometers have been constructed in various different forms, depending for their operation on the expansion of a liquid, the expansion of the vapor of a liquid or the expansion of a gas. These thermometers have been used extensively for ranges of temperature up to 800 deg. F.

A new compensated gas-filled Bristol recording thermometer has recently been developed for recording the lower ranges of temperatures, such as atmospheric temperatures, temperatures of water, temperatures of brine in refrigeration systems, etc., and found satisfactory in numerous tests. These thermometers are equipped with a patented compensating device which automatically corrects for changes of temperature at the recording instrument.

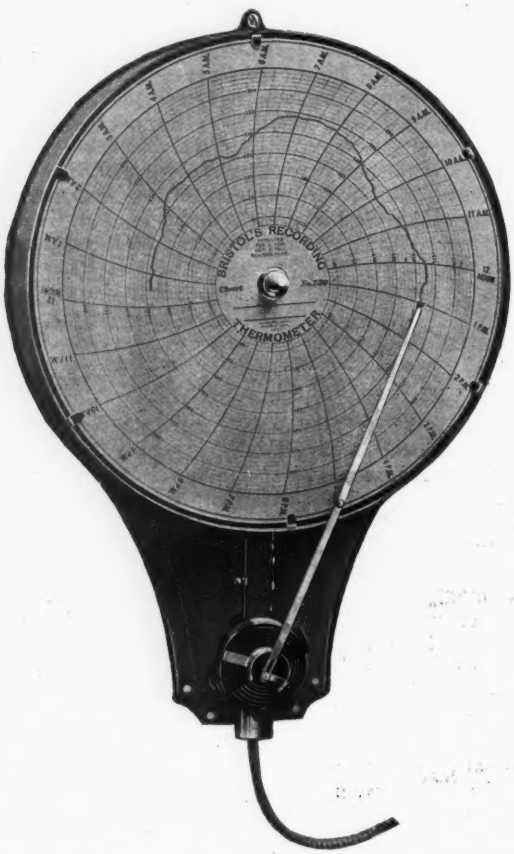


FIG. 1. BRISTOL'S CLASS III RECORDING THERMOMETER, INTERIOR VIEW

Bristol's gas-filled class III recording thermometers are equipped with sensitive bulb and flexible capillary connecting tube and a pressure tube, the sensitive bulb and flexible connecting tube and spiral pressure tube all being filled with an inert gas under pressure. Changes of temperature at the sensitive bulb cause corresponding changes in the pressure of the confined gas and these changes in pressure are measured and recorded by the recording instrument, the interior construction of which is shown in Fig. 1. The sensitive bulb is usually about 10 in. long and ¾ in. in diameter and the volume of gas contained in this sensitive bulb is very large in proportion to the volume of gas contained in the fine capillary connecting tube between the sensitive bulb and the recording instrument, this making the error due to changes of temperature along the connecting tube negligible.

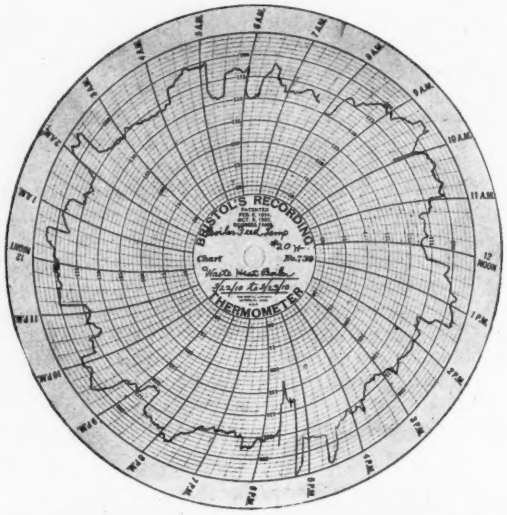


FIG. 2. RECORD OF FEED WATER TEMPERATURE

The important new feature of Bristol compensated gas-filled recording thermometer is the compensating attachment for the spiral pressure tube, shown in Fig. 1, since a thermometer equipped with this compensator gives the same readings or record when the temperature at the recording instrument changes as it would if the temperature at the recording instrument remained constant. The need for such a compensator can be illustrated by the application of a recording thermometer for recording temperatures of brine in a

refrigeration system. The temperature of the atmosphere at the point where the recording instrument was installed might change, although the temperature of the brine at the point where the sensitive bulb was installed remained constant and a recording thermometer for brine temperature should, of course, be so constructed that it would be affected only by changes of temperature at the sensitive bulb.

Figure 2 shows a record of feed water temperature as recorded by one of these instruments, the chart having range of 40 to 225 deg. F. It will be noted that the scale of this chart has uniform graduations

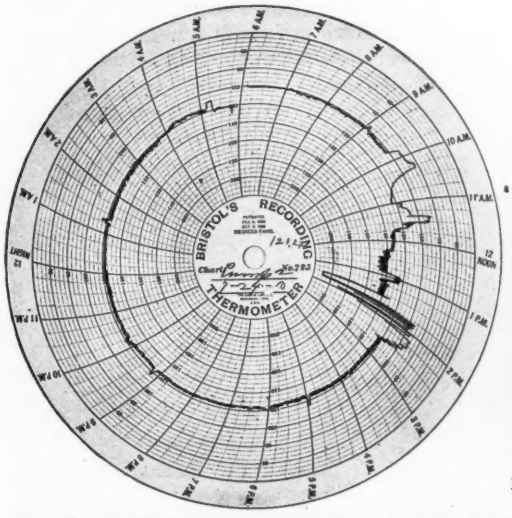


FIG. 3. TEMPERATURE RECORD OF CONDENSER WATER

over the entire range and this makes it possible to use the Bristol-Durand Radii Averaging Instrument for computing the average of the feed water temperatures for the 24 hr.

Figure 3 shows a record of condenser water temperature, as recorded by one of these thermometers on a chart having range of 40 to 220 deg. F. It will be noted that this chart was a reversed scale of uniform graduations. For condenser water temperatures the reversed scale is a desirable feature, as the average temperatures are usually lower than 125 deg., whereas the temperatures are likely to reach boiling point occasionally, at times of loss of vacuum in the condenser, as shown by the record in Fig. 3 between 1:30 and 1:45 p. m.

REMOVING SOOT FROM THE GREEN ECONOMIZER

THERE are 2 principal reasons why an economizer gives a much larger saving than would the same amount of extra surface in a boiler; first, because the temperature of the water in the economizer is 100 to 200 deg. colder than the water in the boiler, hence giving a greater tempera-

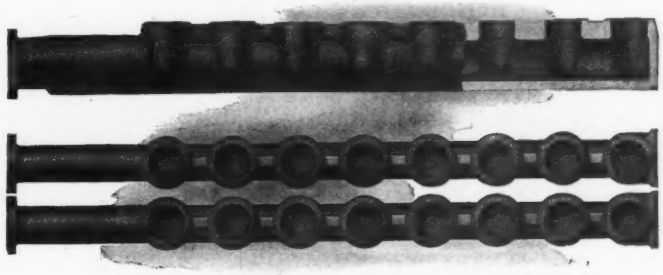


FIG. 1. NEW STYLE OF BOTTOM HEADER FOR GREEN ECONOMIZER

ture head and therefore a greater number of B. t. u. transmitted per square foot; and second, the economizer surface is kept free from soot by the continual action of scrapers.

Inasmuch as soot is a good heat insulator, its thorough removal is of considerable importance, therefore improvements recently introduced by the Green Fuel Economizer Co., tending to more thorough soot removal will be of special interest.

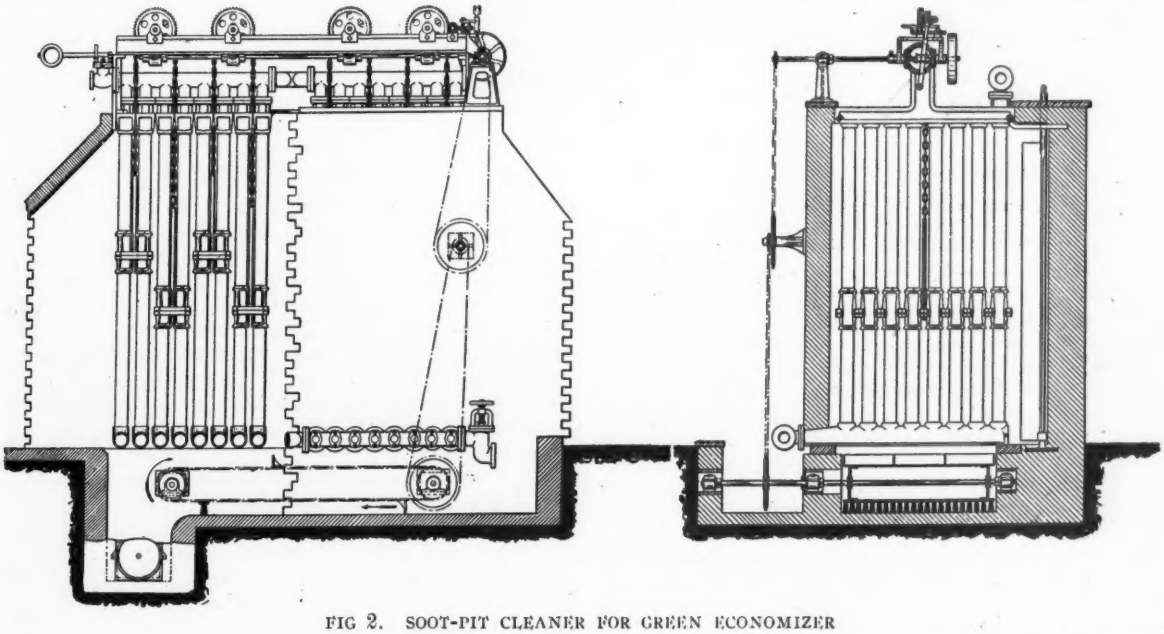


FIG 2. SOOT-PIT CLEANER FOR GREEN ECONOMIZER

Formerly it was customary to make the bottom headers of circular section and the space between the headers was only an inch or so. Occasionally it was found that soot scraped from the tubes by the automatic scrapers would bridge over this narrow opening, resulting in the clogging up of the economizer. In order to avoid this, a header was designed having a cross section of which the depth was about 50 per cent greater than the width, the latter dimension being considerably less than in the old circular section. This change left plenty of room not only for the soot to fall through, but also for the introduction of a man's arm, for the replacing or adjusting of scrapers.

As will be noted, this bottom header is extended sufficiently far beyond the last row of tubes to carry the joint where the bottom branch pipe is attached, well outside of the economizer chamber so that it is not affected by hot gases and the joint is always subject to inspection, metal-to-metal joints only being used inside the economizer chamber.

Cleaning of soot-pit chambers, while an easy matter when they are properly designed, is not a most agreeable job, and is sometimes neglected. Therefore, when so desired, the Green Fuel Economizer Co. will equip its apparatus with the automatic soot pit cleaner shown in Fig. 2. The soot-pit chamber is made with a trough at one end, from which the soot can be conveniently removed, and the bottom of the chamber is smooth. At either end of the chamber are drums mounted on horizontal shafts, one of which extends outside of the chamber, and is driven by a chain from the scraper-driving mechanism above. Endless chains running on these drums carry a brush and scraper which, alternately pass over the bottom floor of the chamber, carrying the soot to the trough or pit at the end. With this apparatus in operation there is no possibility of soot piling up in the soot chamber, although it would seem that the economizer itself would deserve inspection at sufficiently frequent intervals to make the unnoticed accumulation of such an amount of soot improbable.

DETERMINING ACCURACY OF INDICATOR SPRINGS

By E. K. Uebe

THE indicator is unquestionably the most necessary instrument for the operating engineer, and its value can hardly be overestimated. The indicator diagram is the only means by which to ascertain the action of the steam in the engine cylinder, to determine the efficiency of an engine, and to detect internal wastes. It is, therefore, of vital importance that the indicator can be relied upon to be absolutely accurate in its performance which especially applies to the piston spring the most essential part of the indicator.

Unless the exact tension of the spring is known errors will result from its use, and the determinations made with the indicator will be of little or no value. A long-felt want for a reliable instrument for testing indicator springs has been filled with apparatus illustrated.

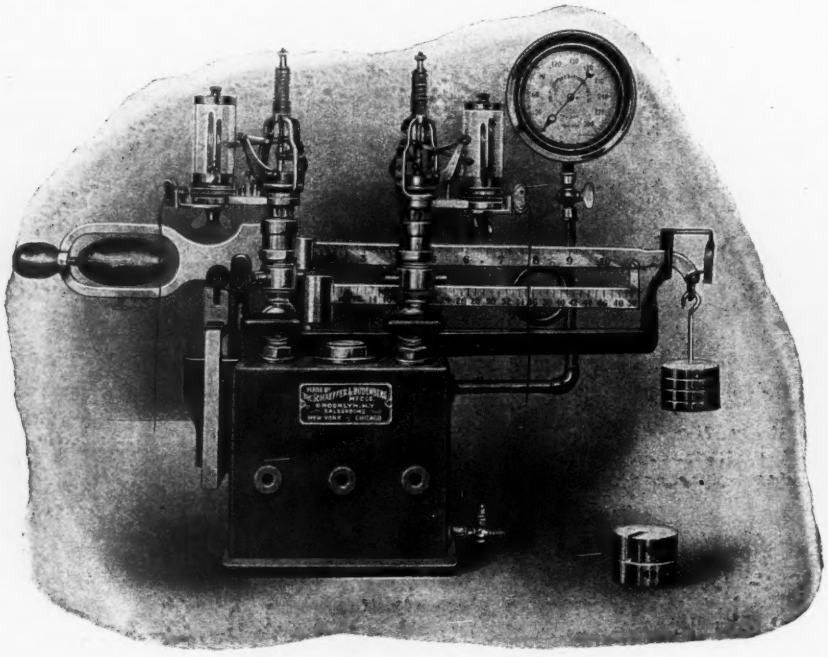


FIG. 1. INDICATOR TESTING MACHINE

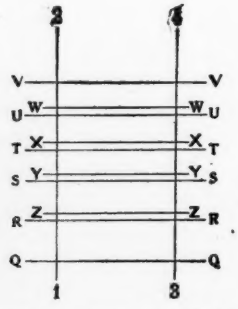


FIG. 2. TEST DIAGRAM

This apparatus, which is made by the Schaeffer & Budenberg Mfg. Co., consists essentially of a closed vessel made of cast iron, capable of resisting internal steam pressures up to 200 lb. per square inch. The steam pressure in the vessel is measured by a gage of special construction consisting of a piston of ½ sq. in. area and which is free to move in an inclosing cylinder.

The lower portion of the piston is pointed and rests in a yoke which is suspended on the knife-edge of a pair of scales mounted on top of the closed vessel. If the scales are previously balanced, before admitting steam into the vessel, it is evident that the reading of the scales will give the pressure acting on each element of the vessel equal in area to that of the piston. The scales are graduated to fiftieths of a pound which permits of very close readings.

In testing indicator springs, steam is turned on into the vessel to gradually warm it and allowed to blow through the connections and indicator cocks to remove

any particles of dust or grit which may have accumulated there, shut off steam again and screw indicator in its place, putting paper on the indicator drum, on which 2 vertical lines are rules as 1-2 and 3-4 Fig. 2.

Press the indicator pencil against the drum and draw a horizontal line Q Q, at the point thus marked. Then set the poise of the scale at say 5 lb. and admit steam into the vessel gradually rising in pressure until the scale floats. When the pressure is exact draw the line R R and so on for successive pressures of 5 lb., until the limit of the scale is reached. During this operation the motion of the indicator pencil is continuously kept upward, if at any moment the pressure rises too high, it is lowered by manipulating the valves, below the required amount and then gradually raised to the desired point.

When the indicator pencil has reached its highest position, the steam pressure is allowed to fall gradually and a series of similar lines, as W W, X X, Y Y and Z Z drawn during the descent of the piston. The motion being continuously downward. The distance between any two of these lines as Z-R, Y-S indicates the loss due to friction of the indicator.

The special advantage of this machine, besides its absolute accuracy, is that the indicator springs are tested in the individual indicator in which they are used and under actual steam pressure which is as near to the actual working conditions as possible.

The indicator spring testing apparatus serves also for testing pressure gages which can be connected to the 3 openings in the front side of the vessel provided for that purpose, and the readings are verified by the indications on the scales and the test gage shown in the illustration.

WHILE PREPARING TO BANK the fires in the engine room of the Empire Laundry, at Poughkeepsie, N. Y., on February 10, the engineer in charge, Albertas Hawley, discovered on the shovel, just as he was about to toss it into the furnace, a bomb filled with dynamite, covered with black paper and with a percussion cap and fuse. The bomb had been carefully concealed in the coal nearest the furnace door and which was likely to be used first.

A TUBE CUTTER AND EXPANDER

THIS new device for cutting, trimming and expanding boiler tubes has been devised to make as easy as possible a part of the work in a boiler plant which is always desirable, but necessary. It is a screw feed device, which in 2 min. can be changed from a cutter to an expander. It is arranged as is shown in the illustration, with a ratchet handle so that it can be operated in confined places, and in many places where the old styles of expanders could not be used.

By means of the screw feed, the use of a hammer is entirely eliminated, as the screw expands the rolls with an even pressure, and insures a perfect job. The rolls are made tapering to conform to the taper of the mandril, thus giving even pressure across the full thickness of the tube sheet. In Fig. 1 the device is shown equipped with the cutters, and the rollers are standing at one side, while in Fig. 2, the cutters which fit into the same place as the rollers, have been removed and the rollers put in. In both operations the ratchet does the work, and so no wrench is needed.

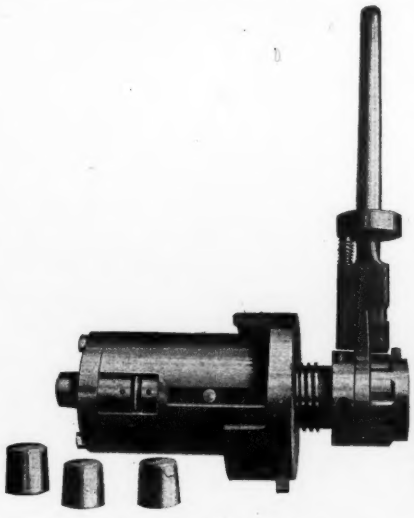


FIG. 1. THE LIBERTY COMBINED RATCHET CUTTER

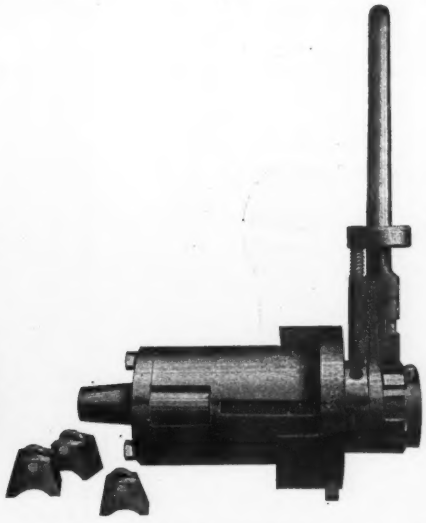


FIG. 2. THE LIBERTY COMBINATION AS A ROLLER EXPANDER

FIG. 3. THE CUTTER WITH EXTENSION HANDLE

Where preferred, a plain expander without the ratchet is used and this can be made to use both rolls and cutters; also the ratchet device can be ordered and attached at any time.

Figure 3 shows the cutter equipped with an extension wrench for operating in the smoke box end of a boiler or in a return flue boiler where it is not convenient to get at the work with the short handle and ratchet. This is arranged with pipe connections so that one set of handles operates the screw feed, while the other does the cutting or expanding as may be required. These devices are manufactured and for sale by the Liberty Manufacturing Co. of Pittsburg, Pa.

WHEN THE WORK is piled up so that you can't see the way out, tackle the job you "hate worst" first. After that the rest will be easy.

ADAPTIVENESS is the peculiarity of human nature.—Emerson.

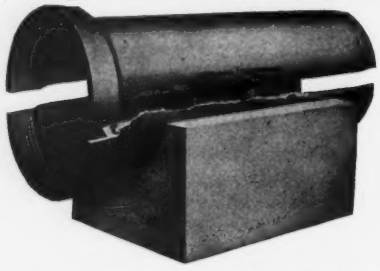
ECONOMICAL STEAM TRANSMISSION

THE question of the transmission of steam with a minimum of heat loss is one of material interest to all producers of power. It not infrequently happens that the machinery to be driven is located some distance from the steam generating plant and the heat units in the steam must either be transferred into mechanical or electrical energy or else the steam itself must be conducted to the point at which the power is required and there converted. The efficiency of steam transmission largely governs the determination of the proper point for the changing of steam into some other form of energy.

In conducting steam some distance from the point at which it is generated, the principal factors governing the efficiency are loss of heat through radiation, and through leakage, secondary considerations being the loss of kinetic energy through friction in pipes.

Relative Loss in Transmission

A LOSS OF HEAT by radiation can be largely elimited by the proper insulation of steam conducting pipes. The following comparative figures taken from Prof. R. C. Carpenter's book on Heating and Ventilating, show a decided saving in heat units conveying steam rather



PORTLAND CONDUIT AS USED IN THE TESTS FOR LOSS OF HEAT

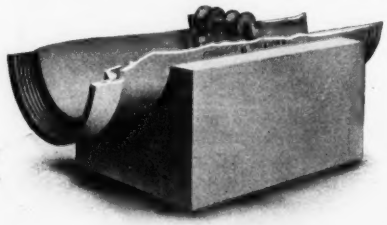
than transmitting power either mechanically or electrically. These figures are based on the loss of power in transmitting 100 hp. 1,000 ft.

By line shafting	25 to 40 per cent
By electricity—line loss	2 to 5 per cent
Transforming from mechanical to electrical and vice versa	20 to 30 per cent
Total loss	22 to 35 per cent
By conveying steam—	
Naked steam pipe in air	37 to 45 per cent
Pipe covered with solid wood and earth	11 to 13 per cent

Comparing these figures it will be seen that transmitting power can be more economically accomplished by conveying steam through properly insulated pipes than by either shafting or electricity. A test of 600 ft. of 6-in. pipe insulated and protected by the Portland sectional conduit method shows even greater efficiency than Prof. Carpenter's figures. The accompanying cuts show some details of this system. With steam at 83 lb. pressure this line of pipe showed an efficiency of 88.7 per cent as compared with uncovered pipe in free air. Noting that Prof. Carpenter's figures give the actual mechanical loss in transmitting steam through naked pipes as 37 per cent to 45 per cent, the loss if the pipe were insulated by the Portland sectional conduit system would be from 4.2 to 5.1 per cent.

Following is the report of a test on the installation of Portland sectional conduit installed at Phillips and Abbott academies, Andover, Mass., conducted by George H. Barrus, consulting engineer.

The outside diameter of the pipe was 6.68 in., giving an outside circumference of 1.75 ft., and the length from end to end 608 ft., so that the area of the pipe



LOWER HALF OF PORTLAND CONDUIT WITH PIPE SUPPORT

surface enclosed in the conduit was 1,064 sq. ft. The area of surface of elbows and connecting pipes at the inlet and outlet, which was covered with hair felt, was 6 sq. ft., giving a total radiating surface of 1,070 sq. ft.

Two tests were made, one on Aug. 11, with high-pressure steam at 83 lb., the other on Aug. 12, with low-pressure steam at 6 lb., each test lasting for 5 hr. For the high-pressure test the total weight of water drawn off was 529.25 lb. or 105.85 lb. an hour. This was 0.0989 lb. per square foot of pipe surface and the steam had 3 per cent of moisture on entering, so that the condensation per square foot of surface per hour corrected for moisture was 0.0987 lb. The temperature corresponding to the steam pressure was 325.8 deg. F. and the average temperature of water drawn out was 306.4 degrees. Assuming an external temperature of 70 deg., the temperature difference between the steam and the air was 255.8 deg. From these results it was computed that 95,455 B.t.u. was the heat loss per hour by radiation or 0.349 B.t.u. per square foot of pipe surface per hour for each degree difference of temperature between the steam and the air.

From previous experiments on pipes in still air it has been shown that the corresponding loss with bare pipe would be 3.1 B.t.u. so that the saving by the use of the covering was 88.7 per cent.

For the low-pressure test, the weight of water drawn off was 243.5 lb. or 48.7 lb. an hour, showing 0.0454 lb. per square foot of pipe surface per hour, which corrected for the 3 per cent moisture in the steam gave 0.0451 lb. condensation. Temperature of the steam corresponding to 6 lb. steam pressure was 229.7 deg. F., and the average temperature of water drawn off was 222.6; the difference in temperature between the steam and the air was 159.7 degrees. Computed from these data the results were: Total B.t.u. loss per hour by radiation, 46,663; loss per square foot of pipe surface per hour for each degree temperature difference between steam and air, 0.273 B.t.u. Under the conditions the corresponding loss from bare pipe would be 2.1 B.t.u., or the saving by the use of the covering was 87 per cent.

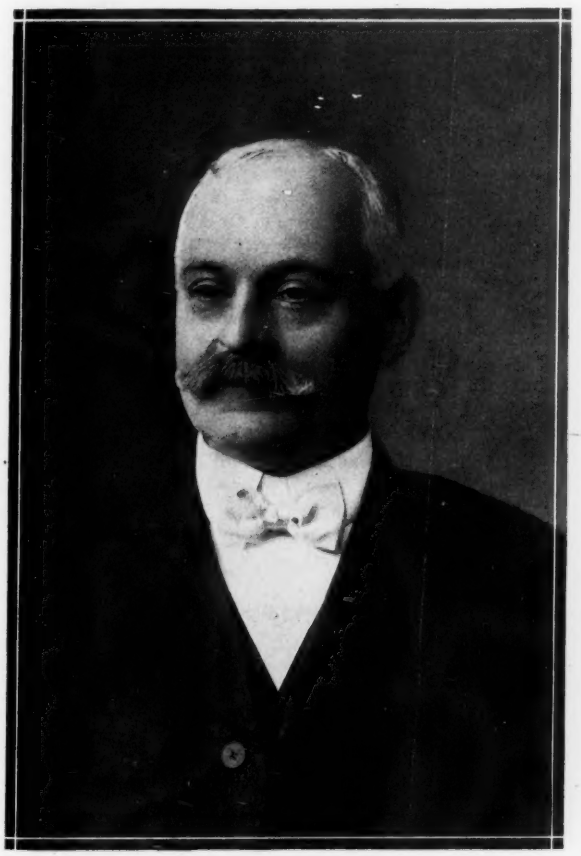
CORRECTION NOTE

Attention has been called to 2 typographical errors in the January issue. On Page 5 at the bottom of the second column it is stated: "The velocity will be $380\times4\frac{1}{2}$." This is an error, as will be seen from consultation of the practical tables. It should be $480\times4\frac{1}{2}$. Also at the bottom of Page 114, first column, the expression $0.615\times2\times125$ is made to equal 14.425. This should be 15.425, or practically 15.43 which is carried all the way through the rest of the computation.

DEATH OF WILLIAM B. MASON

WM. B. MASON, who for a long time had been ailing, with diabetes and for 4 weeks prior to the end had been confined to his house, died at his home in Dorchester Lower Mills, Mass., on February 4. Mr. Mason was born in Freeport, Me., and early in life learned the trade of machinist in the Grand Trunk Machine Shop. After coming to Boston as a young man, he worked as engineer in stationary and marine plants, and afterwards joined the Navy as machinist, being assigned to the U. S. S. Omaha where he served for 2 years on Pacific cruises off the west coast of South America.

Leaving the Navy he returned to Boston, and became an engineer in the Cressey & Noyes organization and



WILLIAM B. MASON

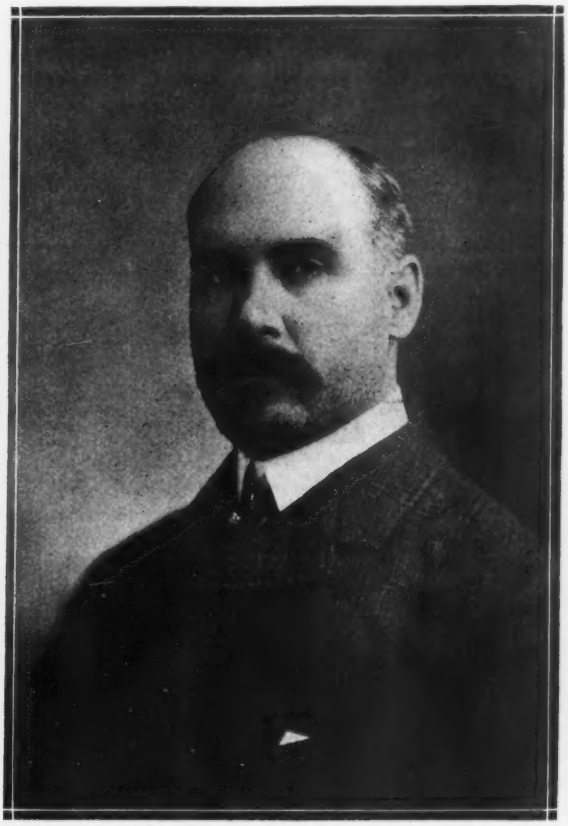
soon perfected his first invention, a governing regulator. This was soon followed by the Mason reducing valve which is now used on ¾ of the locomotives in this country and which permits of heating of cars by steam from the locomotive. In 1883 he formed the Mason Regulator Co., of which he was president at the time of his death, the company being incorporated for the manufacture of his devices.

At his factory was built the first automobile steam engine for the Stanley Motor Carriage Co., and some 6000 engines were turned out there.

Mr. Mason was a member of the American Society of Mechanical Engineers, and of the New England Railroad Club. He leaves a widow and a daughter, Mrs. Eva Maybery of Brunswick, Me.

LOUIS ROSS ALBERGER, DECEASED

LOUIS Ross Alberger, for many years president of the Alberger Condenser Co. and the Alberger Pump Co., died on Jan. 1. Mr. Alberger was born in 1864 in Buffalo and after education in the Buffalo schools attended Yale for 3 yr., left before graduation to enter business with his father in Buffalo. J. L. Alberger was for several years prominent in vacuum processes in connection with the salt industry, and into this business the young man went for his original business training. The vacuum process involved large vacuum pumps and the production of high pressures, and in 1887 Mr. Alberger went to New York and joined the organization of Henry R. Worthington in the condenser department, where he remained until 1901. At that time he founded the Alberger Condenser Co., and subsequently the Alberger Pump Co., to manufacture the pumps needed in connection with the Alberger condensers and also for other uses. Mr. Alberger has been a prominent member of the engineering societies and has built up a business which is in the very front rank of condenser, pump and feed heater manufacturers.



LOUIS ROSS ALBERGER

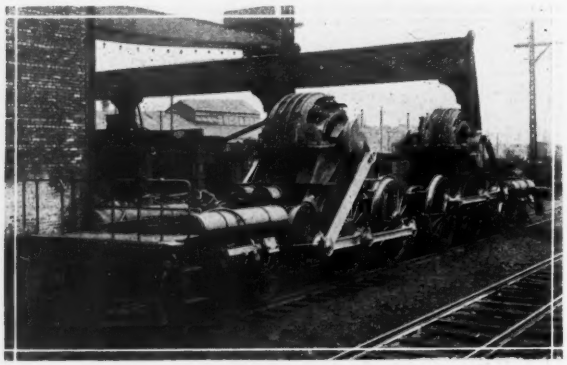
NEWS NOTES

AS A PRECEDENT in the case of unjust defense set up in law suits, the decision in the United States Circuit Court at Fergus Falls, Minn., in the case of International Harvester Co., of America, vs. Charles Cater is worthy of notice, because it establishes in conformity with the decisions which have been rendered in Michigan, Indiana

and Ohio that the purchaser of an article cannot avoid paying for the property purchased by undertaking to plead illegality of contract of purchase and sale because the seller was a so-called trust or combination. This decision is in furtherance of the policy of preventing people from getting other's property for nothing under the pretense of buying it; the establishment of this principle will be welcomed by all honest business concerns and men.

WM. D. PURCELL has been appointed manager of the New York branch of the Home Rubber Co., with office at 80-82 Reed St., and will represent that company in the sale of its entire line of mechanical rubber goods, including the N. B. O. packing. His telephone number will be Worth 4460.

THE PENNSYLVANIA RAILROAD has ordered from the Westinghouse Electric & Manufacturing Co., 9 electric locomotives in addition to those already purchased. These will aggregate about 40,000 hp. and are of the same type as those now in operation in the Manhattan



Terminal in New York City, and are to supplement the 24 already in use. The new locomotives are to be delivered by July 1. A view of the locomotive without the cab is shown in the illustration, the mounting of the motors and running gears with method of driving and connection being shown.

ALLIS-CHALMERS Co. has announced the appointment of E. T. Pardee, formerly manager of its Boston office as manager of its power and electrical department. Mr. Pardee is well qualified for this position, having been actively connected with the selling of power and electrical apparatus during most of his business life. Mr. Pardee began his business experience with the Western Union Telegraph Co., of Syracuse, New York, with which company he was connected from 1885 to 1891, following this he represented the Fort Wayne Electric Corporation at Omaha and San Francisco from 1891 to 1898, being advanced in the latter year to manager of the Boston office, which position he held until 1901. In that year he entered the Boston office of the Bullock Electric Manufacturing Co. as a salesman and remained with Allis-Chalmers Co. in a similar capacity after it had acquired the Bullock Co. Mr. Pardee was made manager of the Boston office of Allis-Chalmers Co. in 1905 and in his work there has made a host of friends. Mr. Pardee will be succeeded as manager of the Boston office of Allis-Chalmers Company by T. J. Lynch, who for the past 7 yr., has been manager of the Toronto office of Allis-Chalmers-Bullock, Limited. Prior to that he had been connected with the construction department of Allis-Chalmers Co. Mr. Lynch was born and spent his early life in Boston and is now returning to his home city.

ON APRIL 3, 4, and 5 will occur a concrte example of the get-together spirit in business in the form of a joint meeting of the American Supply & Machinery Manufacturing Association, The National Supply & Machinery Dealers' Association and the Southern Supply & Machinery Dealers' Association, in triple convention at Louisville, Ky.

The American Supply & Machinery Manufacturers' Association is composed of a large number of prominent manufacturers of machinery, power plant accessories and general mill supplies, and has been in existence about 7 years, accomplishing much toward placing the business on a higher ethical plane, and the development of an understanding of good business principles. A unique feature is the conduct of a general promotion or advertising department for the benefit of members, which involves a general advertising service of a distinct nature for which no extra charge is made. This bureau is located at 55 Woodbridge St. W., Detroit, Mich., and is under the direct supervision of Wm. M. Chamberlin, who for many years has been engaged in general advertising work in the power plant and supply field.

General headquarters of the association are at 309 Broadway, New York City, under the charge of F. D. Mitchell, secretary and treasurer.

CATALOG NOTES

A VERY COMMENDABLE LITTLE booklet of 68 pages, called The Golden Stream, has been recently issued by the International Harvester Co. of America.

This booklet covers a multitude of vital facts relative to the plain, ordinary, everyday cow in a very interesting manner. Such up-to-date topics as The Dual Purpose Cow, Bovine Tuberculosis, How to Make a Babcock Test, Rations for Dairy Cows, The Feeding Value of Silage, and Advantages of Dairy Farming, are discussed. In general, the purpose of the book is to impress the farmer with the proper relation of the cow to our modern civilization as the source of a golden stream of wealth.

Numerous illustrations throughout the booklet showing record-making cows and herds of various milking breeds, silos, dairy barns and interiors, etc., greatly enhance the value of the booklet. It will be greatly appreciated, especially by farmers and dairymen. A copy of the booklet may be obtained by writing the company or any one of the various I. H. C. branch houses.

THREE IMPORTANT PUBLICATIONS on the subject of electric lighting are Bulletins 5C, 8B and 15, published by the Engineering Department of the Electric Lamp Ass'n. The first one covers multiple lamps for 110 and 220 volts, and of capacities of 25, 40, 50 watts. The second covers Mazda miniature and low voltage lamps to run at 1½ up to 20 volts, and having efficiencies of 0.79 to 1.31 watts per candle power for automobile lamps, general battery lamps, a large low voltage lamp, and sign lighting. The third bulletin is on electric sign lighting, and gives data on performance and application of Mazda and Carbon lamps for this purpose. As is always the case of the bulletins of this department, these are filled with engineering information and data besides descriptions of the apparatus on which they treat. They can be had by application to the department at Cleveland, Ohio.

IN A NEW 48-PAGE Catalog recently issued by the Lagonda Manufacturing Co., of Springfield, Ohio, is discussed the relative advantages and different con-

ditions under which it is most suitable to use the various types of boiler tube cleaners. This line includes several types of water driven cleaners, also a full line of air and steam driven cleaners, and a type of mechanical cleaner which is suitable for driving by the Lagonda External air or steam motor, or belting to steam engines or electric motors. Besides boiler tube cleaners, other boiler room devices are briefly described, such as the Lagonda Water Strainer for removing impurities from boiler feed or condenser water, the Automatic Feeding device for removing scale from Stirling boilers without entering the drum, the Lagonda Double Action cutoff valve for automatically shutting off steam in case of break in the line, besides other devices such as tube cutters, reseating machines, etc. Copies of this catalog may be had upon application.

BULLETIN 9465, describing the Moore Light for Color Matching, has just been issued by the Western Electric Co. This is declared to be the only artificial illuminant which gives exact daylight color values, and it is being introduced into shops, mills and other establishments where color values are of great importance. The bulletin contains a description of this illuminant and of its uses and operation. A page is devoted to the list of concerns now using this, and another to tabulated dimensions, data, etc.

BOILER MAKERS' TOOLS, made by the J. Faessler Mfg. Co., of Moberly, Mo., are illustrated and described in the company's catalog No. 27.

A BOOK ON THE SLIDE RULE, by Hinckley & Ramsay, especially designed for boiler inspectors, engineers and cranks, has come from the Engineering Text Book Co., of Boston, Mass. It deals with the parts of the rule and its purpose, the method of finding numbers, the operations of multiplication, division, finding of decimal equivalents, computing the circumference and area of circles, cube roots and cubes, the use of the upper scales for square roots and squares, the use of the inverted slide, finding the position of the decimal point, and the adaptibility of the slide rule for solving problems. It is a book of 104 pages, and has been carefully and simply prepared to serve the purpose for which it was designed. In the leather binding the price is $1.75, and in red cloth binding, $1.25.

SPIRAL RIVETED PIPE, Forged Steel Pipe Flanges, Hydraulic and Exhaust Steam Supplies, are described in pamphlet No. 30 of the American Spiral Pipe Works, of Chicago.

THE ELECTRICAL POCKET BOOK for 1911, published by the Mechanical World, of Manchester, England, contains, besides 200 pages of mathematical and electrical tables and rules, a complete diary for the year. The material has been carefully prepared, is put in convenient form for use, and is fully indexed.

BRISTOL'S PATENT STEEL BELT LACING, which comes in a number of different styles and sizes, is fully described in Bulletin No. 152, just issued by the Bristol Co., of Waterbury, Conn. No. 1 style, which is especially adapted to leather belts, comes in 7 sizes for different widths; No. 11 style, made especially for rubber, cotton and woven belts, comes in 9 sizes. A style made with staggered points for all kinds of belts, giving the same effect as a 2-row thong lacing, comes in 2 styles with any desirable width in each style, while another style, the staggered point, which is made up with 3 sets of prongs in each section, is arranged to use any number of sections for different widths of belt and is made up in different lengths of prong for different thicknesses. The full line is described in the bulletin.

MOUND TOOLS FOR THE ENGINEER is the title of a neat catalog which has just been issued by the Mound Tool & Scraper Co., of St. Louis, Mo. This booklet contains illustrations of the various tools made by this company, consisting of scrapers, cold chisels, packing tools, beading tools, drills, etc.

FROM THE WAGNER ELECTRIC MFG. CO., of St. Louis, Mo., we have received a beautiful art calendar which would be an adornment in any room or office. This calendar may be had for the asking and anyone receiving it will be highly repaid for sending in a request to the company.

A NEW 40-PAGE BOOKLET is issued by the Joseph Dixon Crucible Co. of Jersey City, N. J., entitled Graphite Products for the Railroads. It covers the entire Dixon line which is of interest to railroads and is attractively illustrated by photographs showing views of stations, yards, locomotives, signals and other railroad equipment.

FROM THE FRANCE PACKING CO. of Tacony, Philadelphia, comes a folder on the subject of France Metal Packing for ammonia, steam and air, in which is shown the results which users have gotten and also a list of plants equipped with this packing which is guaranteed for 3 years and sent on 60 days' trial.

FRICTION CLUTCHES is the title of a catalog just issued by the Carlyle Johnson Machine Co., Manchester, Conn. The catalog is enclosed in a handsome cover of 2-toned blue, with a clutch cut and company monogram embossed thereon, and is filled with attractive illustrations. This catalog is larger and more complete than previous ones, and deals almost exclusively with the driving of machinery through friction clutches, special attention being paid to the driving of machinery from line shafting, thus eliminating cross belting, countershafting, etc. There is special mention made of clutches for cutoff coupling work for use in connection with marine motors, as a one-way clutch for which work this type of clutch is particularly adapted. The lists are very complete, extending to clutch parts. Copies will be sent free to interested parties.

FROM THE Alliance Engineering & Sales Co., of Milwaukee, Wis., comes Bulletin No. 101, describing the Alinder-Reliance Power Hammer, which is made in sizes for handling work from 1¾ up to 8 in., running at from 300 to 175 blows per minute. The special features of the hammer are that it forges without adjustment of the head, both thick and thin pieces, that it has small power consumption, and that the driving mechanism, located at the base, does not disturb the stability of the machine.

TYCOS-ROCHESTER, is the name of a booklet sent out by the Taylor Instrument Co., of Rochester, N. Y., describing various types of Tycos Thermometers and their use for different purposes.

INTERESTING LITERATURE has been received from the Precision Instrument Co., of Detroit, Mich. This refers to the work of gas analysis and the operation of the Precision Simmance-Abady Patent Combustion Recorder. It illustrates and describes the instrument and its method of operation, and with the catalog proper are enclosed supplement No. 1 showing the use of the recorder for gas works, supplement No. 2, showing the arrangement of gas analysers for chemical works. A sample record taken from the recorder, and an article on the A B C of combustion in boiler settings by J. Abady.

PUMPING MACHINERY for operation by any power is described in a handsome catalog issued by the Deming Co., of Salem, Ohio, and bearing on the 3-tone cover the embossed title Deming Power Pumps. It is Catalog H and is full of good information. Not only are all the different styles of pumps made by the Deming Co. described and dimensions and capacities given, but there are directions for installing and operating power driven pumps, illustrations showing the arrangement of power pumps for special uses such as running elevators, irrigation, deep well pumping and the application of centrifugal pumps and of automatic tank pumps, but at the end of the book are found tables on air compression, on pump capacities, the horsepower required to raise water, feed required for boilers, the loss of pressure through pipes and the capacities of tanks. The book has over 180 pages and is a complete book of information on the subject of power pumps and power pumping.

FROM THE BRISTOL CO., Waterbury, Conn., comes Bulletin 126, showing the Bristol Class 2 Recording Thermometers and illustrating the instruments as assembled, the method of applying the thermometers and the different styles of bulbs used for different classes of work. It shows also the different styles of charts furnished with these recording thermometers for all ranges of temperature and for different periods of time, as may be desired.

J-M RUBBER VALVES, a valve for every condition, are described in a folder just issued by the H. W. Johns-Manville Co., of New York City.

A SOUVENIR of the Joint Summer Meeting of the British Institution of Mechanical Engineers and the American Society of Mechanical Engineers, has been printed by the Crosby Steam Gauge & Valve Co., in the form of a pamphlet, showing the James Watt Museum at Birmingham, some of the original letters of Watt, and photographs of some of the early Watt Engines. A comparison is also shown of the first steam engine indicator invented by Watt and the latest pattern of Crosby Indicator with outside spring.

DE LAVAL STEAM TURBINE CO., of Trenton, New Jersey, has just published a 120-page book, which is a most complete commercial exposition of the steam turbine. The work is devoted to single-stage turbines, with and without gears, but in order to explain the advantages of the several types of turbines it takes up the various questions connected with available energy in the steam between different pressures and temperatures, effects of pressure and vacuums, steam friction, forms of nozzles and buckets, strength of wheels, disks and drums, vibration of rigid and flexible shafts, proper speeds for driven machines, such as direct and alternating-current generators, centrifugal blowers and pumps, advantages of rope and belt drives for many situations, etc. The construction of the DeLaval turbine receives very full treatment, an exhaustive description being given of the methods adopted for insuring safety, such as the special form of the wheel, the safety groove which allows the buckets to be thrown before the wheel itself will rupture, and the provision of safety rings embracing the hub of the wheel, so that in case of breakage of the shaft the wheel will be brought to rest. In addition to the geared turbine, impulse turbines of the single and 2-stage types are illustrated, as are, also, numerous applications of turbines with and without gears applied to driving generators, pumps, blowers, etc. Centrifugal boiler feed pumps driven by turbines without gears are described as specially suited because of their simplicity and reliability to the requirements of steam power plants. Among other illustrations we notice 2 of the DeLaval Multistage turbine, which is adapted for large sizes and of which a number are now in service.

"A PAIL WITH A TALE" is the title of an interesting folder sent out by Adam Cook's Sons, 708 Washington St., New York, giving a short history of the growth of Albany Grease as a lubricant.

"FACTS" is the title of an instructive little booklet issued by the American School of Correspondence, of Chicago, in which it tells of the history, the equipment, the growth, the principles, the methods, the text books, the students and the character of the school, its position in the educational courses of the country and what its future promises. It is an interesting story of work well done and is worth while reading.

SPRAGUE CONDUIT PRODUCTS, catalog 436, tells of the construction of iron armored conduits, Greenfield Flexible conductors, Greenfield steel armored coils, and the boxes, fittings, and tools for installing these conduits. The catalog is issued by the Sprague Electric Co., 527 W. 34th St., New York City. In its bulletin 111, the Sprague Electric Co. gives a partial list of installations of engine type generators, which it has made.

AN INTERESTING SET of Bulletins come from the De La Vergne Machine Co., New York City, Refrigeration Dept., covering the following subjects: Bulletin 103, on the De La Vergne Standard Counter Current Atmospheric Ammonia Condenser; 104 on the De La Vergne Standard Ammonia Purifier; 105 on the De La Vergne Vertical Ammonia Compressor; 106 on the De La Vergne Standard Horizontal Ammonia Compressor; 107 on the De La Vergne Junior Horizontal Ammonia Compressor; 109 on Ice Manufacturing Plants by the Kenn system. All these are filled with information, with interesting descriptions and with attractive cuts.

GENERAL ELECTRIC CO. recently issued Bulletin 4787, which is devoted to the subject of Wires and Cables. The publication should be of considerable service to purchasing agents, central station managers, and all having occasion to buy or use wire and cable for any service. The book contains much data but no prices.

Also revised Bulletin 4791, which supersedes its previous bulletins on the subject of Feeder Voltage Regulators. The bulletin describes the company's regulators of the induction type and switch type, single and polyphase, hand operated and automatically operated. It contains connection and dimension diagrams, together with weights of the various regulators described.

Bulletin No. 4813 describes an oil break switch adapted to use on alternating current series arc systems for sectionalizing feeder systems, cutting in and out transformers, and similar classes of service requiring a switch to be operated under load.

In Bulletin No. 4812 are described Small Direct Current Generators ranging in capacity from 1¼ to 20 kw., and suitable for lighting small plants, hotels, residences, factories, or mills, where the average length of the feeder circuits is 400 yards or less, and the maximum length is not greater than ¾ of a mile. The generators are provided with sliding bases which facilitate adjustment of the belt, and can be installed on

the floor, wall, or ceiling. With the exception of the 1¼ kw. generators, all of these are provided with commutating poles, so rendering a change in position of the brushes with change of load unnecessary. This bulletin contains table of ratings, weights and dimensions.

A new edition of the company's bulletin on Watthour Meters for Switchboard Service, the number of which is 4662-A, tells of recent developments and gives illustrations of instruments and diagrams.

Bulletin 4790, under the title of Electric Mine Locomotives, supersedes its previous bulletin on the same subject. This bulletin illustrates and describes in considerable detail 2 and 3-motor mine locomotives of various capacities, arranged to operate either singly or in tandem. The bulletin describes also the company's gathering locomotive, which consists of any one of its standard locomotives equipped with a motor-operated reel, to which is attached flexible heavy insulated cable. These gathering locomotives can, therefore, be operated for some distance beyond the terminal of the trolley wire by merely slipping a hook fastened to one end of the cable over the trolley wire. The reel operates automatically, and the locomotive is operated in the same manner as when the trolley is used.

FROM THE SMITH GAS POWER CO., of Lexington, Ohio, comes a bulletin giving valuable information on the experience of present users of gas producer plants. As is natural, the testimony is in regard to the Smith gas producers and the questions to which answers have been returned are in regard to the kind of power plant used before gas was put in and the cost of operation, also as to the kind of fuel used, difficulties encountered, work of caring for the plant and cost of operating since the installation of producer gas power. A large number of records have been secured and the bulletin is interesting reading.

FROM THE SPRAY NOZZLE CO., of Boston, Mass., comes Bulletin No. 10, illustrating and describing its system of cooling nozzles and ponds for cooling condensing water.

NEW PUBLICATIONS issued by the Department of the Interior, Bureau of Mines, are as follows: Bulletin No. 4, Features of Producer Gas Power Plant Development in Europe, by R. H. Fernald. Bulletin No. 5, Coking and Washing Tests of Coal at the Denver, Colo., Testing Plant. Besides these there have been reprinted Bulletin No. 9 on Producer Gas Power Plant Development in the United States, by R. H. Fernald, and Bulletin No. 11, on Purchase of Coal under Specifications, by Geo. S. Pope. Copies of these may be had free by application to the Bureau of Mines, Washington, D. C., one copy of each bulletin being sent to a person. Request should be addressed to the Director of the Bureau of Mines.

THE GENTLEMAN FROM MISSOURI; a book for doubters, is the title of a book which according to the statement was written between rounds by the night watchman of the Massachusetts Saw Works, Chicopee, Mass. If this be true the night watchman must be a genius and must have unlimited time between rounds, for the booklet shows the evidence of careful thought, original ideas, and attractive arrangement. It tells all about the hacksaw blades made by this company, and why they are different from others. The booklet itself is also different from others, and is full of human interest as well as good technical arguments.

TRADE NOTES

THE AMERICAN SHIP WINDLASS CO. report the following recent sales of Taylor Stokers: 3 stokers to the Detroit Steel Castings Co. for 3 200-hp. boilers; 1 stoker to the Peters Cartridge Co., King's Mills, Ohio, for a 400-hp. B. & W. boiler; 4 stokers to the Tremont & Suffolk Mills, Lowell, Mass., for 1400 hp. B. & W. boilers; and 8 stokers to the Springfield Street Railway Co., each of which is to be used with a 375-hp. B. & W. boiler.

SIXTY YEARS in business in any line is a good record. When that length of time has been applied to the manufacture of a product which has, and is, meeting a decided need and is a success, that record becomes really enviable. The Baragwanath firm, of Chicago, has that record. It manufactures feed-water heaters and condensers exclusively, and it is needless to say that its products have improved constantly during this long period until they have reached a stage of perfection appreciated only by those who have used them.

J. H. WILLIAMS & CO. is putting on the market a new wrench called the Spark Plug Wrench, which has a box end adapted for ½-in. spark plug and has an open end adapted for ⅜-in. cap screw, nut or 9-16 in.

set screw. It is drop forged from steel and of shape convenient for use about combustion engines on all kinds of work. This and the Vulcan Auto Tool and the Ratchetless Ratchet wrench will form articles of daily use in the engineer's kit.

HUNDREDS OF SMALL FACTORIES in this country are using city gas for fuel, as was the case at the Bowen Grocery, Allentown, Pa., until recently, when it installed its own gas making plant. This gas making plant was installed by the Dornfeld-Kunert Co., of Watertown, Wis., and a letter lately received shows the saving effected:

"With our 60-hp. producer we are furnishing enough gas to run our 30-hp. engine, which supplies all the electric light current we need in the building, besides furnishing power for our elevator coffee mills and refrigerating plant; also furnishing gas for our confectionery stoves, coffee urns, our kitchen range and bake ovens.

"Our power heretofore has cost us not less than $3,000 a year, with gas at 90 cents a thousand and electric current at 2.6 cents per kw. This same amount of power with the gas producer will cost us no more than from $800 to $1,000 a year, with coal at $4 a ton."

The gas producer plant consists of a gas generator and a gas cooling and cleaning tower, together with a gas booster, the whole occupying a space of 9 by 17 ft. The plant is filled with coal every 3 hr. and the ash removed once in 24 hr. The plant is in continuous operation day and night and there is always sufficient gas to meet the requirements.

DURING THE PAST MONTH Swartwout Centrifugal Separators for either oil or steam have been sold to General Ry. Signal Co., Rochester, N. Y.; City of Dublin, Ga.; National Screw & Tack Co., Cleveland, Ohio; Mt. Airy Lumber Co., Mt. Airy, Md.; Weidmann Silk Dyeing Co., Paterson, N. J.; Southern Cotton Oil Co., Chicago, Ill.; Lackawanna Steel Co., Lackawanna, Pa.; The Gorham Bros. Co., Mt. Pleasant, Mich.; Lib-

erty Ladies College, Liberty, Mo.; West Bay City Sugar Co., Bay City, Mich.; Michigan Buggy Co., Kalamazoo, Mich.; The C. S. Mersick & Co., New Haven, Conn.; Garford Co., Elyria, Ohio; McMeylor Industrial Co., Bedford, Ohio; Fort Smith Lumber Co., Plainview, Ark.; Wright & Alexander, Rochester, N. Y.; Page Milk Co., Ubly, Mich.; Blair Silica Brick Co., Sarah Furnace, Pa.; and Columbia Steel Co., Elyria, Ohio, by the Ohio Blower Co. of Cleveland, Ohio.

York Manufacturing Co. reports the following among its recent sales: Hotel Athens, New York, N. Y., one 10-ton refrigerating plant; Westerberg & Williams, New York, N. Y., one 20-ton and one 4-ton refrigerating plant for James McCreery & Co., New York, N. Y.; Edna Ice & Light Company, Edna, Texas, one complete 5-ton ice making plant; Chas. Wolff Packing Co., Topeka, Kan., one 225-ton cross compound refrigerating machine and high pressure side; I. J. Nathan, Marlin, Texas, one complete 25-ton ice plant; Chas. Bonini, Pittsburg, Pa., one 20-ton and one 10-ton refrigerating machine and high pressure side; Prag Distilled Water Ice Co., Delhi, India, one 11-ton refrigerating machine; Bristol Ice Cream Co., Bristol, Tenn., one 10-ton refrigerating plant; Atlanta Ice & Coal Corporation, Atlanta, Ga., one 160-ton cross compound refrigerating machine for its Albany Artesian Ice Plant, Albany, Ga.; McComb City Ice Factory, McComb, Miss., one 10-ton compression side, and 3500 feet of 2-in. direct expansion piping.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED—Young man 23 years of age would like position as engineer. Four years' experience with steam plant. Can come at once. Address Charles Ferris, 23 N. Grove St., Grand Rapids, Mich. 3-1

POSITION WANTED—As fireman or assistant engineer in small stationary plant or some where around machinery; 3 years' experience on a dredge boat; good habits. Address Box 163, Practical Engineer, Chicago, Ill. 3-1

POSITION WANTED—Mechanical Engineer is open for a position where economy is wanted. Fully equipped to make all tests of plants, also open to make estimates for new plants. Box 162, Practical Engineer, Chicago, Ill. 3-1

POSITION WANTED—By young man 25 years of age, as oiler or work around a power plant, permanent position desired. Reference. Address Box 482, Highland Park, Ill. 2-2

POSITION WANTED—Engineer would like to take charge of small plant or act as assistant in large one. Have had 7 years' experience. Familiar with the operation of both A. C. and D. C. generators. W. Break, River Rouge, Mich. 2-2

POSITION WANTED—By young man 21 years of age as hoisting engineer or as stationary engineer in small plant. West preferred. W. F. Judkins, Bow, Mich. 2-2

POSITION WANTED—As stationary engineer steam or gasoline engines. Can do own repair work and am machinist and run D. C. dynamos. Have Minnesota license. Moral habits. Address J. L., R. No. 3, Box 39, Fairfax, Minn. 2-2

Help Wanted

WE WANT AN ENGINEER in every town and city in the U. S. to give us a little assistance, for which we pay liberally in cash. For particulars write to Box 599, Rochester, N. Y. 3-1

ENGINEERS WANTED IN every town to sell Wiechmann Tube Cleaners for water and fire tube Boilers. Perfection in the art. Attractive proposition. Clyde Mach. Wks. Co., Chicago. 3-2

HIGH GRADE SALESMAN WANTED by prominent manufacturer of piping equipment of every description, valves, fittings, flanges, etc. This is an unusual opportunity for an aggressive, capable salesman whose selling experience has been along the line of high pressure power plant installations, but all applicants will be considered. Give age and full account of experience in first letter. Address Box 161, Practical Engineer, Chicago, Ill.

WE HAVE a stunning proposition for an engineer in every town or city. Little time required. Will not interfere with regular work. Write for particulars. Address Box 136, Practical Engineer. 8-tf

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

For Sale

FOR SALE—$1.50 WILL BUY castings and all material for our neatly designed automatic steam engine. Engine will develop 1-16 H. P. Has fly-ball governor and rotary valve with adjustment for wear. Blue prints and instruction sheets 25c. Complete engine ready to run $6. Elgin Wheel & Engine Co., Elgin, Ill.

FOR SALE—ONE D. C. 220 VOLT 35 KW. Western Electric Dynamo, speed 1150. One marble switchboard complete, with ammeter volt and rheostat with two circuit cables to connect same to dynamo. 1100 ft. No. 000 wire, 750 ft. No. 0—wire, weather proof, good insulation, all in good running order. Write for prices to Pierce Milling Co., Pierce, Neb. 1-3

Patents and Patent Attorneys

PATENTS—WANTED, IDEAS—Manufacturers are writing for patents procured by me. Send for free 72-page guide book and list 200 inventions wanted. R. B. Owen, Dept. 28, Washington, D. C. 3-3

PATENTS—Guide Books with 100 Mechanical Movements. Perpetual motions book. 50 illustrations. Mailed free. F. C. Dieterich & Co., Patent Lawyers, Washington, D. C. 2-2

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. 10-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the inventors. Handbook for investors sent upon request, 186 McGill Building, Washington, D. C. 4-tf

Miscellaneous

EVERY ENGINEER should know about the new system of Vacuum Heating, which can be installed without payment of royalty. Particulars will be cheerfully furnished. T. L. Reeder, 1413 W. Jackson Blvd., Chicago.